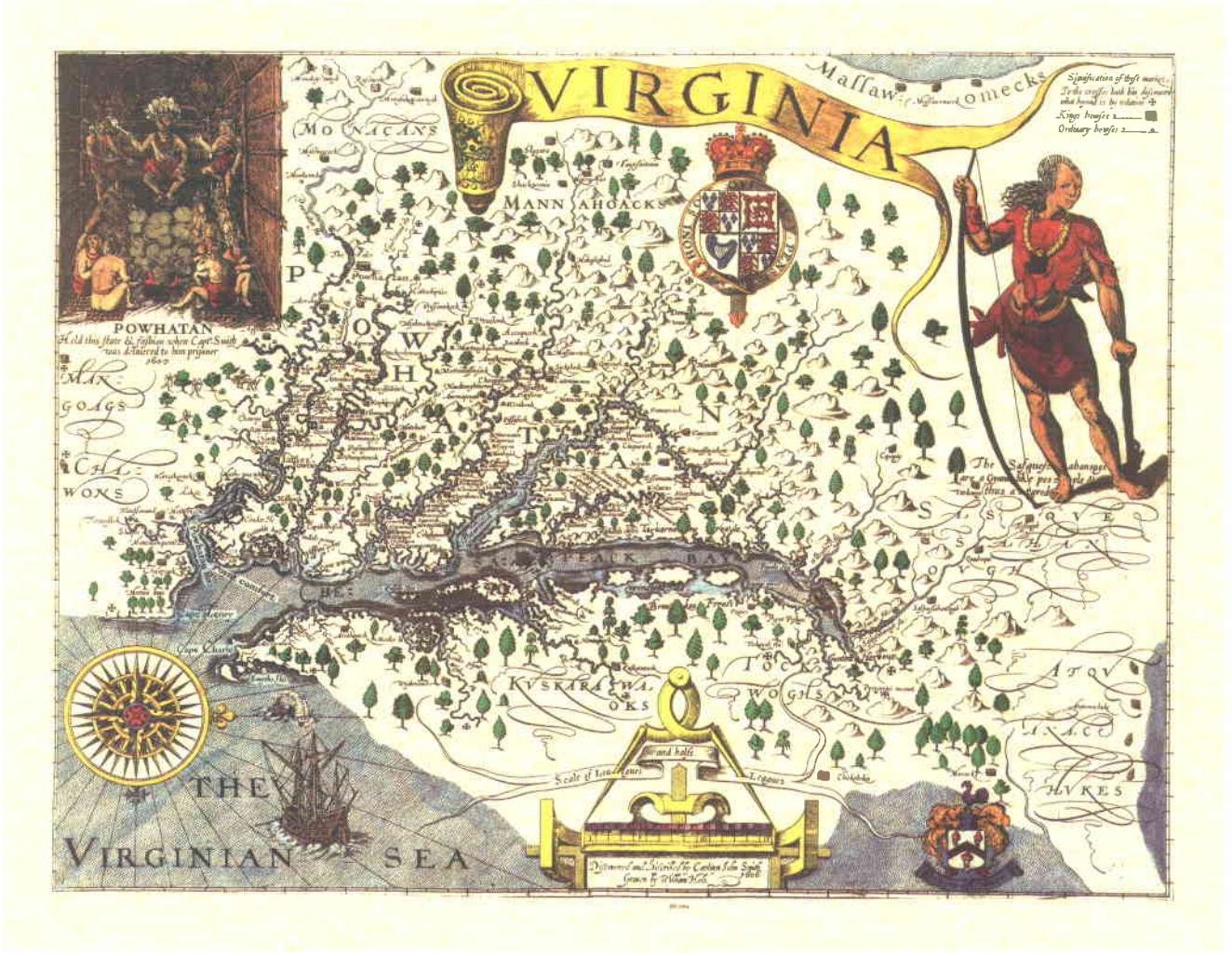
VIRGINIA DIVISION OF MINERAL RESOURCES
PUBLICATION 176

EARLY ATTEMPTS OF ENGLISH MINERAL EXPLORATION IN NORTH AMERICA: THE JAMESTOWN COLONY

Lisa L. Heuvel



COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES
Edward E. Erb, State Geologist
Charlottesville, Virginia

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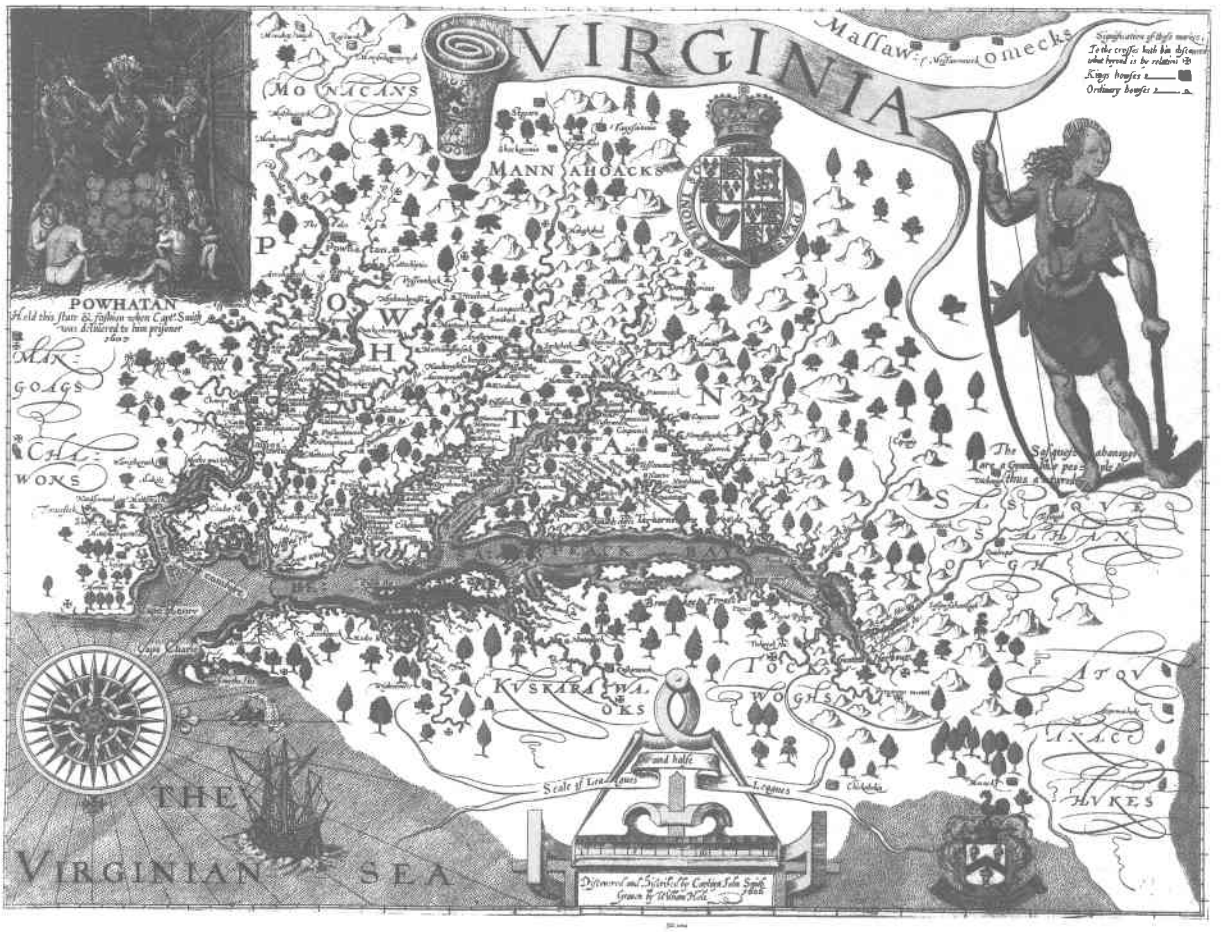

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COVER: John Smith's "Virginia" was separately published in London in 1612 and was also included in the Oxford publication of John Smith's *A Map of Virginia: With a Description of the Countrey, the Commodities, People, Government and Religion [1612]* (Courtesy of The Colonial Williamsburg Foundation).

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"Here are abundance of Iron Mines/here bee silver and gold mines but they cannot bee found out/other mines I know not"

" .....I sent some heavy earth and a peece of fullers earth....."

Michael Upchurch in letters to John Ferrar in approximately 1650 (Upchurch, Ferrar Papers).

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ABSTRACT

Modern accounts of early New World exploration and colonization often overlook significant geologic and technical foundations of mineral exploration. These accounts, instead, focus on the English colonists' overall failure to find gold and subsequent success at growing and exporting tobacco in Virginia. The 1607 Jamestown Colony was one of several English investment attempts to discover and exploit precious metals, gems, non-precious metallic ore, and medicinal plant and clay commodities in modern-day North Carolina, Virginia, and Maine (Figure 1). Plans for expeditions and colonization regularly included "mineral men" (prospectors), assayers, miners, and goldsmiths. Familiar with period technology or artisanship, they were as well prepared to explore for minerals as the state of Old World and New World knowledge allowed at that time. Even so, the English did not duplicate Spanish successes in amassing great mineral wealth in the Western Hemisphere. Native resistance to territorial and cultural encroachment, bad luck and near misses in mineral exploration, and the transition from alchemy to a science-based understanding

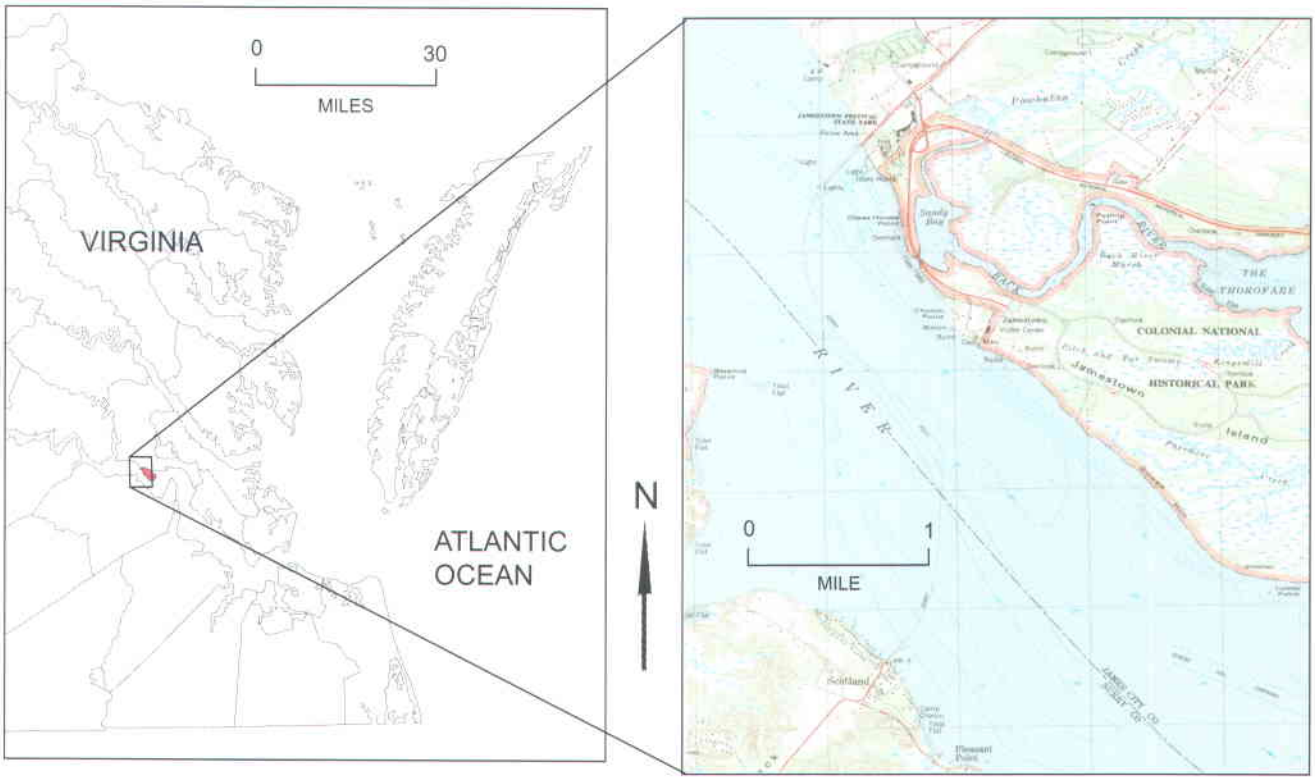

Figure 1. Location of Jamestown and Jamestown Island. (Map on right from the USGS 7.5-minute Surry quadrangle.)

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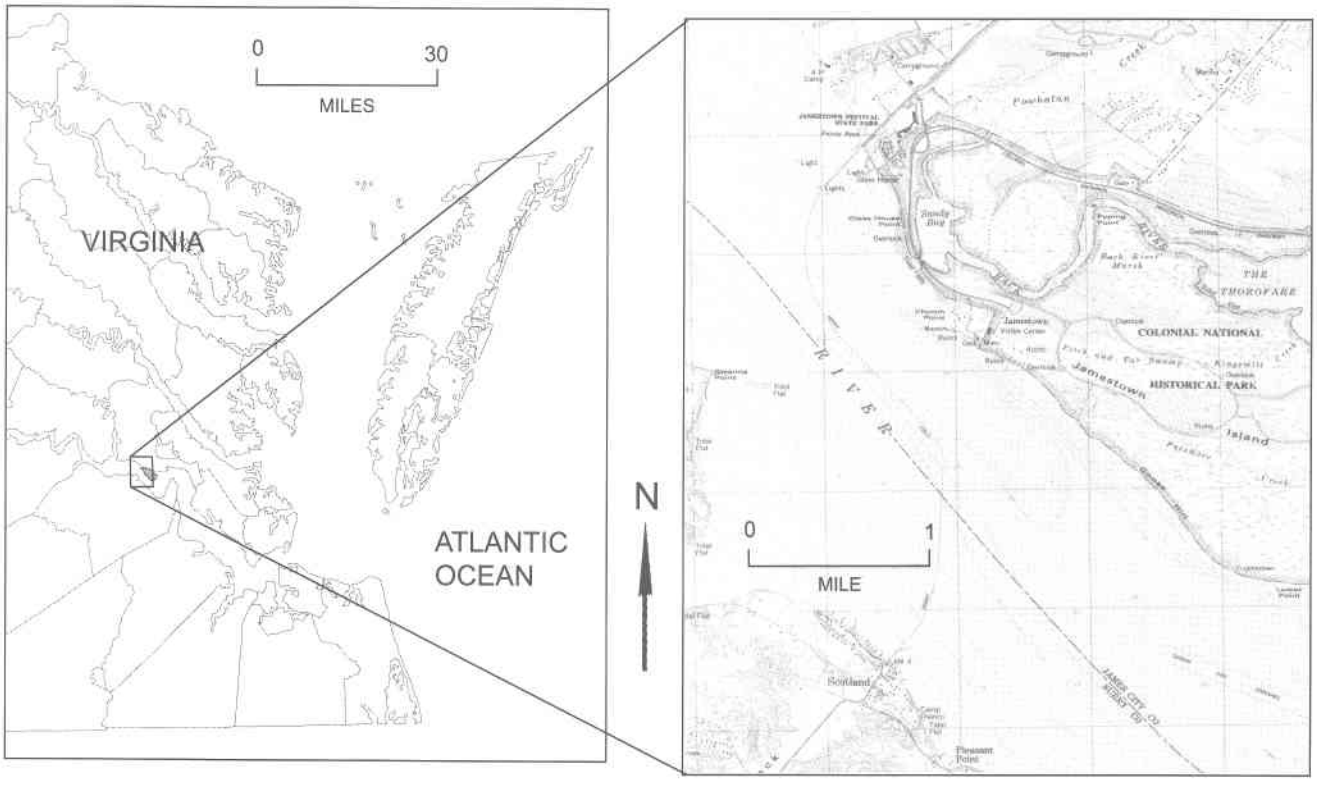


Figure 1. Location of Jamestown and Jamestown Island. (Map on right from the USGS 7.5-minute Surry quadrangle.)

of mineral occurrence prevented timely or early success of a mineral-based economy in Virginia. An English toehold in the New World was established through a tobacco-based economy, seemingly limitless supply of fuel and renewable resources, and other realized opportunities. Economic mineral development, however, was achieved in Virginia and North Carolina as technology, exploration, and westward expansion increased.

INTRODUCTION

Colonial mineral exploration by the English in the New World has long been considered a footnote to the larger story of Virginia. However, mineral exploration's influence on the contested landscape of British America and the evolution of cultural interaction should be re-evaluated from a new perspective.

Both the English and the indigenous peoples were irreversibly locked into an adaptation process that evolved over time through cultural contact. The scope of this intercultural relationship can be demonstrated and better understood through geo-archaeological evidence and a closer examination of primary source documents.

English and European colonists did not necessarily recognize the complex skills of the native cultures they encountered, particularly in relation to the natural environment. A comparison of historical events and geologic documentation shows that English colonists at Jamestown came much closer to precious metals than has been previously credited to them. They projected their knowledge of mining, mineral exploration, and metalworking onto the landscape, using it to express their expectations. Limitations born of territorial hostilities, technology, and unforeseen events were factors in their perceived failure.

Like mineral exploration, attempts to create and support the Virginia iron industry would not bear fruit for the first colonists. Their descendants – and Virginians today – would be the ones to benefit from mineral-related industries, as statistics show. Over 400 different minerals have been found and more than 30 different mineral resources are produced in Virginia at a combined annual value of nearly two billion dollars.

Since gold deposits and successful mining activities are documented in eighteenth- and nineteenth-century literature and physical evidence, why did the English fail in their seventeenth-century efforts? The hypothesis in this paper centers on the limitations of technology on the edge of the English frontier as well as a series of circumstances that can best be described as near misses and plain bad luck, as well as disease and death that seemed to follow the "mineral men" (prospectors) in Virginia. In addition, conflicting perceptions of the landscape by the English and the Powhatans had a profound influence on events in the London Company era.

This new perspective may increase awareness of metallurgical and cosmological concepts underlying the English colonial mindset by 1607, especially as compared to the spiritual and economic perspectives of the Powhatan Indian world. In turn, it may further delineate the scope of cultural interaction in early colonial Virginia. As James Axtell has written, "We cannot afford to privilege one kind of source over another: We need them all if we are to compensate for – when we cannot recover – the evanescent words and gestures that constituted much of the public past of these oral cultures and face-to-face societies" (Axtell, 1997, pp. 2-3). As the first chapter will show, geography and geology expand our understanding of the visual and physical landscape of four centuries ago, alerting us to the possibility – and reality – of different perceptions of a common ground.

AN OVERVIEW OF VIRGINIA, THE WAITING LANDSCAPE

It was not their known world, this Virginia, and European exploration was akin to shining a light through a keyhole. If they could scan a modern nautical chart, mariners, mapmakers, and explorers of the late fifteenth and early sixteenth centuries would recognize Virginia's placement between the parallels 34 and 45 degrees north latitude. Cape Henry, Point Comfort (modern-day Fort Monroe) and Jamestown Island would probably look familiar to experienced colonial mariners. However, Virginia's true size and that of North America would have amazed them. Today's Commonwealth comprises some 42,450 square miles, of which 2,325 are covered by water. The Virginia that King James claimed stretched north to Halifax, Nova Scotia, south to Cape Fear, and west to the Pacific (Gannon, 1985; Watson, 1907). According to modern geologic classifications, Virginia is divided by surface features into provinces. These provinces are, from east to west, the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateaus (Figure 2). Sediments characterize the Coastal Plain province from the coast to the Fall Line boundary or about one-fourth the area of Virginia. The Coastal Plain is composed of unconsolidated sand, gravel, clay, and fossil shells. Rarely, the shells are cemented by iron oxide, calcium carbonate, or other materials. West of the Fall Line are crystalline rocks such as granites, gneisses, phyllite, and basalts in the Piedmont province.

The Blue Ridge province includes high-grade gneisses, greenstone, amphibolite, and schists. Rocks in the Valley and Ridge province include limestone, dolostone, sandstone, and shale. Coal, oil, and natural gas are present in the Appalachian Plateaus province and in Mesozoic basins where the rocks also include sandstone, siltstone, and shale (Sweet, 1983). The potential wealth was just waiting for the colonists to exploit it. The quest for gold and silver was a catalyst for English exploratory and colonizing efforts. Such early hopes were not unfounded, but premature. In 1782, Thomas Jefferson wrote in his "Notes on the State of Virginia" that a "four-pound lump of gold ore" was discovered on the north side of the Rappahannock River, the only such incident reported for the eighteenth century (Watson, p. 549). Beginning in the early 1800s, gold was methodically extracted from visible sources (near-surface lode deposits and placer mining), and then the first reported lode deposit was discovered in 1806 in Spotsylvania County (Sweet, 1980).

By 1837, William Barton Rogers, first director of the Geological Survey of Virginia (1835 – 1841) and founder of the Massachusetts Institute of Technology, wrote, "the working of the auriferous veins of this wide region is destined to become an important branch of the systematic industry of the state" (Rogers, 1835, p. 132). In his "Report of the Geological Reconnaissance of the State of Virginia, Made Under the Appointment of the Board of Public Works, 1835," Rogers wrote extensively of the "gold region." The report included mines in Spotsylvania, Orange, Louisa, Fluvanna, and Buckingham counties, "from many of which rich returns have been returned and under improved modes of operations a still larger profit may be expected." Rogers further observed that mining methods and the process for separating gold from ore were wasteful because "a large proportion of the gold is lost and thrown out with the gravel from which only large masses of the gold have been separated."

Geologist Thomas L. Watson's 1907 "Mineral Resources of Virginia" recorded that the discovery of gold in Orange County by 1829 led to the 1831 incorporation of the Virginia Mining Company of New York. Before the Civil War stopped mining operations for its duration, annual gold production was valued at between $50,000

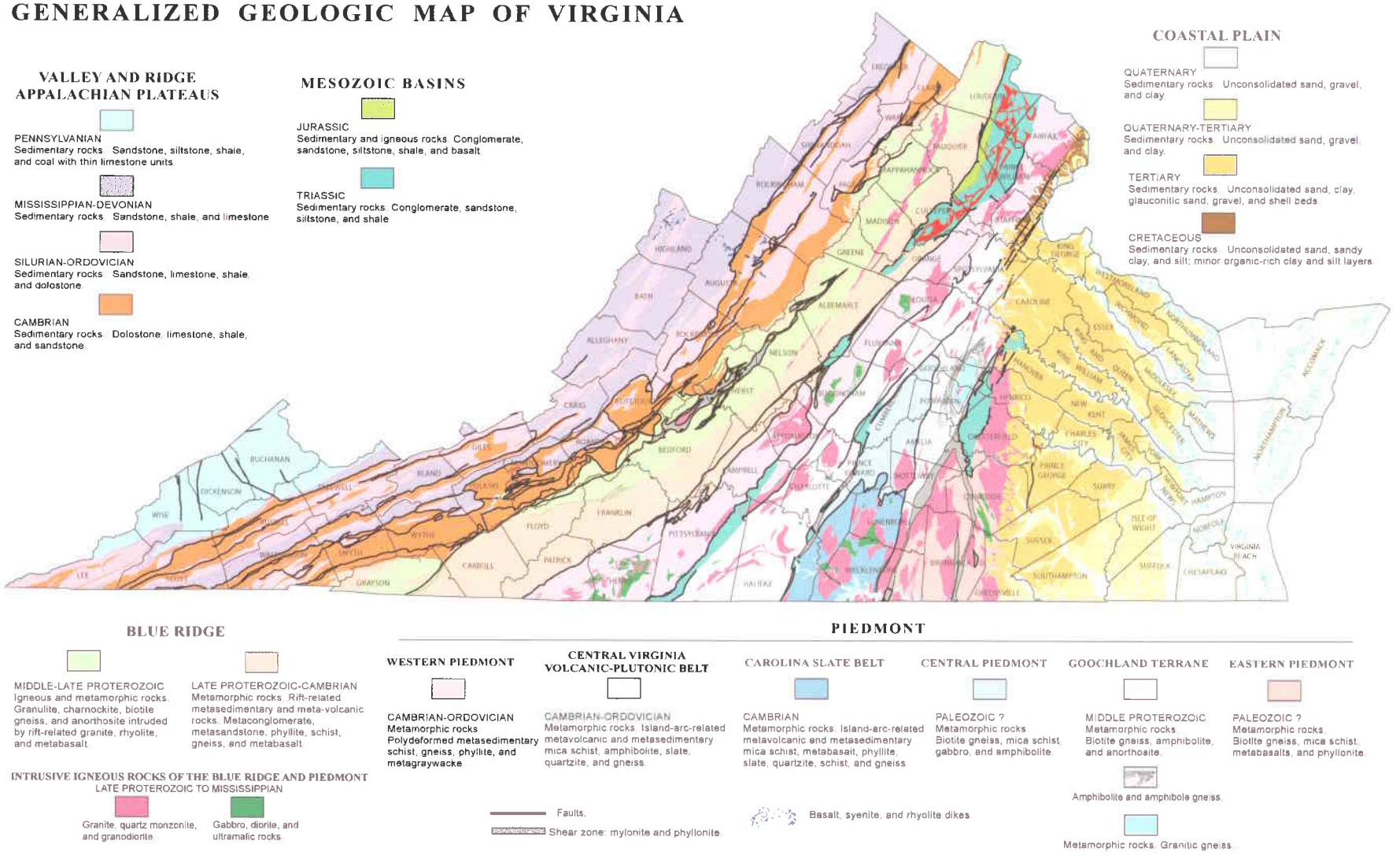
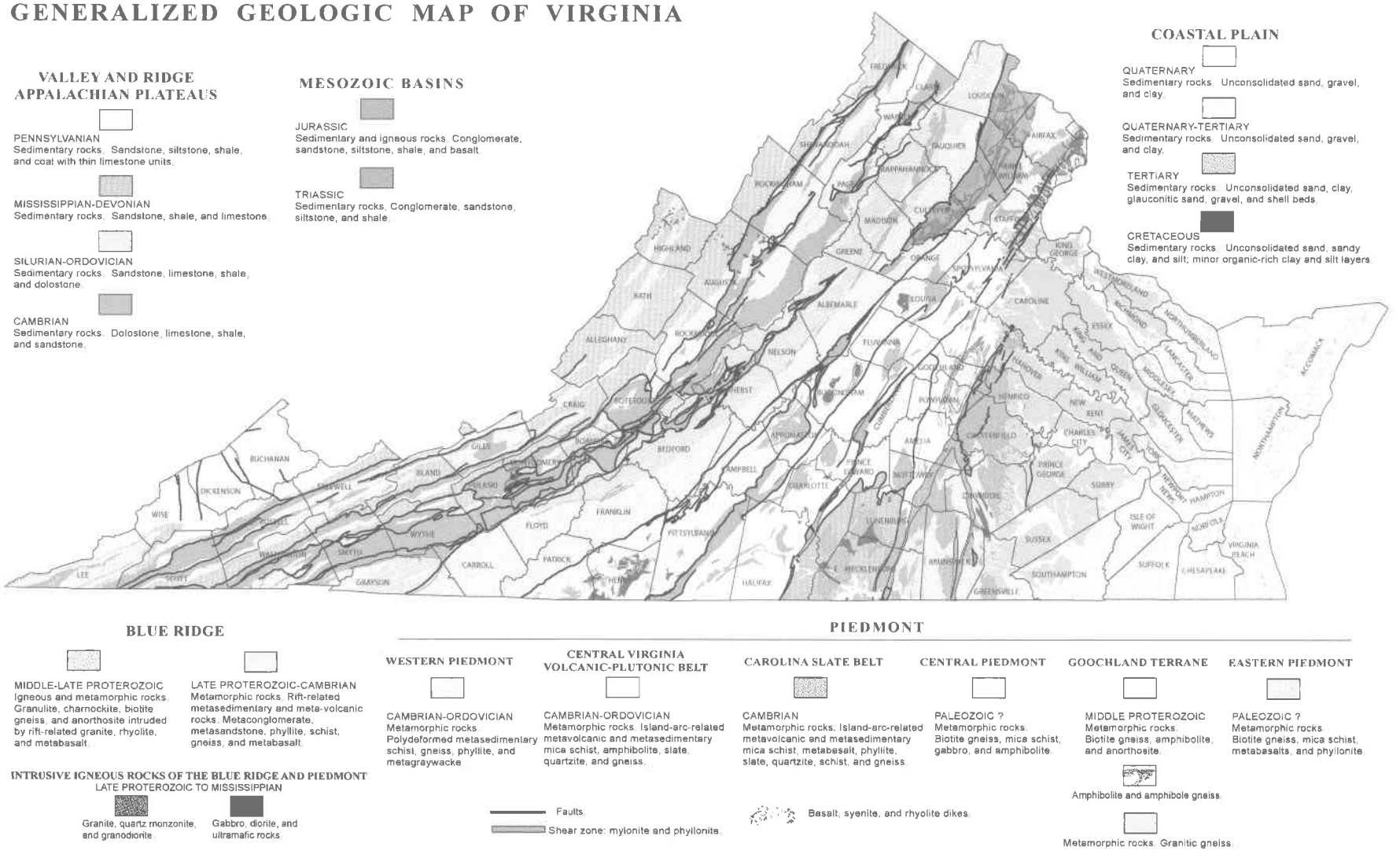


Figure 2. Simplified general geologic map of Virginia. (Compiled by Elizabeth M. Campbell using digital files created by C. R. Berquist from the 1993 Geologic Map of Virginia.)



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and $100,000) (Watson, 1907). Between 1804 and 1947, Virginia mining operations produced more than 98,600 troy ounces of gold (Sweet, 1980). In 1980, Virginia Division of Mineral Resources economic geologist Palmer Sweet reported location data documenting that, out of primary literature references for 301 gold and silver mines, prospects and occurrences, more than 80 per cent were located in the "gold-pyrite belt" (Figure 3). The belt stretches approximately 140 miles from Fairfax County's Potomac River through Buckingham County (Sweet, 1995). This region varies from 12 to 25 miles wide. Colonial mineral exploration by the English in Virginia should be viewed not as a failure born of misinformation and greed, but rather a necessary step toward the revelation no early visionary or explorer would live to see. In addition to gold, silver, copper, iron, and coal, a host of other mineral resources have been mined in Virginia. Iron production began in 1609 with the mining and smelting of limonite, or bog iron. Commercial coal mining dates from 1750 near Richmond (Watson, 1907).

By examining the events and intellectual developments culminating in the London Company phase of Virginia colonization, mineral exploration emerges from period accounts as a series of fits and starts. Although mineral exploration, mining, and iron working were well under way by the seventeenth century in England, these industries did not transfer substantially to the New World compared to Spanish achievements there (Rees, 1967). Spanish mineral exploration in the American Southeast had the same halting results as the English; however, it was clearly overshadowed by the flood of gold and silver reaching

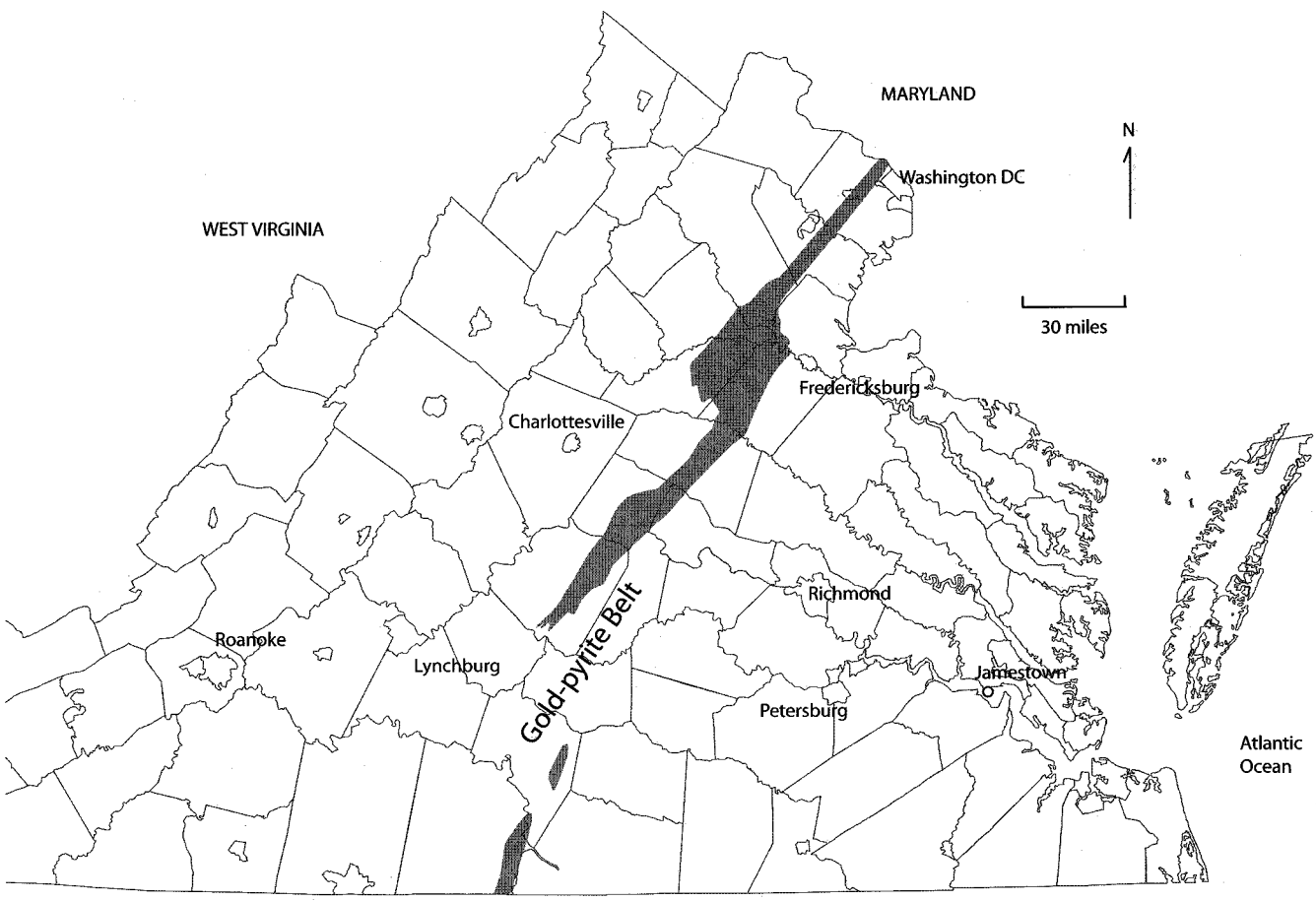

Figure 3. Location of the gold-pyrite belt in Virginia.

Spain from other parts of its New World dominion.

The key to understanding English mineral exploration in Virginia lies in the collective data accumulated by the English and assimilated into a working body of knowledge. This framework of reference was based on available exploratory information and expectations. An "imaginary map" evolved that supported early English efforts to locate mineral resources. England's documented quest for gold and silver, the Powhatans' desire for finished copper and copper products in trade, and the potential value of Virginia iron are known factors in the development of the colony. However, clays and other less-noted mineral resources have not been sufficiently studied in relation to specialized European demand. In addition, the literature has not been reviewed as a "shopping list" of desired mineral commodities other than gold and silver. Potential export value was a driving force in exploring unknown territories, and the imaginary map of English North America was the guide.

If, as Paul Groth (1997) has written, landscape denotes the interaction of people and place as a source of shared meanings and cultural identity, then the geological features of the land called variously "Tsenacomoco," "La Florida," and "Virginia" are integral to understanding its significance as a historical and cultural landscape. The Powhatans, Spanish, and English perceived the landscape and its resources through their own cultural lenses. Within the James River basin, a complex chiefdom under Powhatan's father arose in the second half of the sixteenth century. His son would expand that chiefdom to an estimated 13,000 to 14,000 warriors, women, and children. The chiefdom cut a wide swath across all Tsenacomoco, the modern-day Coastal Plain of Virginia, despite periods of conflict with the Monicans to the west and other tribes to the north and south. It is unknown how many other Algonkians lived to the south in today's North Carolina: Ralph Lane, first governor of the Roanoke Colony, described the region as "very well peopled and towned" (Perdue, 1985, p. 25). As descendants of the indigenous peoples (i.e. pre-Algonkians) who had occupied the land now called Virginia for between 10,000 and 12,000 years, Powhatans in the Pre-Contact Period had the greatest level of familiarity with the woods and waterways. They were the guides for Europeans moving between the Chesapeake Bay and the Fall Line, particularly before the English laid visual claim to the territory with maps of their own. For land and water travel and identification, the Powhatan tribal culture relied on hieroglyphics, physical markers, and oral tradition, all of an ephemeral nature. In "Seeing Beyond the Dominant Landscape," Wilbur Zelinsky (Zelinsky as cited in Groth and Bressi, 1997, p. 158) discusses the ultimately "super potent Anglo-American landscape," noting that:

> The invading Europeans encountered in North America a varied set of genuine preexisting ethnic landscapes that were the result of many generations of cultural revolution. We have only a hazy perception of what most of these places were like in visible, physical terms, and for too many virtually no information at all.

The motivation for Europeans, specifically the English who would reshape the Powhatan landscape via their own physical actions and intellectual concepts, was possession. The motivation for indigenous peoples to offer themselves as guides and informants is more complex. Believing their cooperation to be of short-term consequence (before the balance of power shifted), the Powhatan Indians stood to gain much more than they would lose. Trade for highly-valued copper and high-technology goods such as metal tools, weapons, and cloth provided a prime incentive. For the English, trade supplied short-term value in food and furs, but long-term value in informa-

tion and eventual land ownership. Gregory Nobles (1989) pointed out that trade established European dominance. Meanwhile, New World Indians exhausted goods and resources through trade to the point that land itself or the use of it was exchanged. However, as William Cronon observed, Indians "thought they were selling one thing and the English thought they were buying another" (Cronon as cited in Nobles, 1989, p. 646).

Strategically placed along major waterways in the Chesapeake region, the Powhatans were self-sufficient and linked by trade and communications to other native populations. However, they could not accurately gauge land resources and populations beyond their shores. This was the world and ethnic landscape irrevocably changed by the English, whose moral certainty and national needs propelled them forward. The consequences of exploration and occupation by the English and other Europeans throughout the late fifteenth to early seventeenth centuries would be irreversible.

A MINERAL COMMODITIES MAP OF THE WESTERN HEMISPHERE

European explorers of the fifteenth through early seventeenth centuries were essentially "pilgrims-for-a-price," seeking New World knowledge and possession by divine right. As Michel Foucault stated in "Questions on Geography," "Those seventeenth-century travelers and ..... geographers were actually intelligence-gatherers, collecting and mapping information which was directly exploitable by colonial powers, strategists, traders and industrialists" (Foucault and Gordon, 1980, p. 75).

Much earlier European metallurgical technology in the New World has been documented through archaeological excavations at La Isabela, site of the 1493-1498 colony established by Christopher Columbus (Deagan and Cruxent, 1995). In the Caribbean, placer mining was required to obtain gold and the Spanish used the indigenous natives as laborers (Kicza, 1992). Gold and cedar were factors in Spanish involvement in the Canary Islands beginning in the 1340s, along with slaving. Spain spread European technology in ironworking, metalworking and metallurgy throughout its empire, and gold and silver from mines in Mexico and Peru fueled Spain's royal military operations and empire building (Hook and Gaimster, 1995).

After 1513, Spanish exploration in the colonial Southeast did not yield the same results. As James Axtell (1997, p. 5) noted, "native rumors, wishful thinking, and obliging geotropical theories that planted gold and silver in tropical and semitropical zones – wherever the Spanish happened to land – kept the search alive, even in the face of daunting native opposition and unremitting emptyhandedness." One of the important sources of scientific information on the New World was Gonzalo Fernandez de Oviedo Valdes, Royal Overseer to the mines in Hispañola beginning in 1514. Oviedo was also royally commissioned to write a history of the New World. Some of his actions may indicate already established patterns of colonial mineral exploration in the New World: trading with natives for mineral specimens (in his case, precious stones such as pearls and emeralds) and writing extensively about natural resources.

In the fifteenth century, Portugal, as a maritime power, secured gold and slave profits from the Senegal region of Africa as Portuguese mariners worked southward to the Cape of Good Hope in 1488 (Thornton, 1998). Spanish explorers mapped Florida and moved west questioning the natives about precious metals. To the north, Jacques Cartier had been sent by King Francis I in 1534 and continued to explore New France, which he may have named Canada in 1536. In 1542, it was reported that Cartier had accumu-

lated eleven barrels of what he believed to be gold ore (actually pyrite) and precious stones. Rock crystal quartz specimens were erroneously identified as diamonds, generating the expression "faux comme diamants du Canada" for anything false. In 1604, Samuel de Champlain acted on an account of copper mines in New France from another Frenchman, Captain Prévert of St. Malo, whom he met the previous year. A miner, Mâitre Simon, accompanied Champlain in his three-week expedition with the instructions to keep hammer and chisel ready. During his trip around part of the Nova Scotia peninsula, Champlain kept notes on natural resources and promising areas for settlement. Simon detected what appeared to be a silver mine at modern-day Mink Cove and an iron mine at Waterford. Both occurrences went into Champlain's reports. The modern-day Advocate Harbor was named Port aux Mines by Champlain, who found both copper and amethysts there (both are geologically verified). Champlain cut one large amethyst out of the rocks, broke it in two, and presented the two pieces to two of his noblemen investors. The investors accordingly set the stones in gold and presented them to the king and queen of France (Jones, 1986). In 1604, the French settled Quebec, and in effect abandoned La Florida to the Spanish.

As a by-product of their Atlantic exploration, Spain and France contributed substantial information on mineral resources that can be examined in the context of perception and reality, and be compared for similar patterns of observation and inquiry. In turn, English exploration efforts show related consistencies that will be discussed in this chapter. Elizabethan scholar A. L. Rowse wrote, "The awakening interest in America, from the middle of the century, had at first to feed upon translations, from Spanish, French, Latin. When the English began to go to Virginia themselves in the 1580's [sic], they were able in turn to contribute new information from other peoples, whom we find beginning now to translate from them" (Rowse, 1959, p. 189).

From the Middle Ages on, stone quarrying technology in Europe laid the groundwork for iron technology and metallurgy. German miners were already recognized and in demand across Europe in the twelfth and thirteenth centuries for mining gold, silver, iron, copper, lead, zinc, and tin. The predominant vocabulary for mining became German, underscoring how widely their technical expertise spread (Gimpel, 1977). Paralleling these earlier developments were advances in navigation, cartography, physical science, and technology. At the same time, superstition and science blended to create an atmosphere that has often been taken out of context but should be examined as a product of the times. While alchemy and mystical theory were interconnected, active observation and experience led to two major advances in mining and metallurgical literature in the sixteenth century, born of the practical applications of metalworkers and other workers unknowingly on the frontier of chemistry and geology. As Cyril Stanley Smith wrote in his introduction to "The Pirotechnia of Vannoccio Biringuccio: The Classic Sixteenth-Century Treatise on Metals and Metallurgy:"

> If the development of the chemistry of metals in this period was slow, this was a result of the small number of men interested in such things, the lack of encouragement they received, and the difficulties of communication with each other, increased by a certain reluctance to share knowledge of possible advantage to a competitor. (Biringuccio 1540/1990, Gnudi Trans., *xv*)

Georg Bauer, better known by his Latin name Georgius Agricola, was a practicing doctor and professor who devoted himself to first-hand observation of mining and geology in some of Eu-

rope's great mining centers. Before the publication of his treatise "De Re Metallica" (On the Nature of Metals) and others, the knowledge needed for smelting metal was largely handed down from father to son. Written in 1530 and published after Agricola's death in 1556, this would become the standard text on mining for the next two centuries. The illustrations in "De Re Metallica" show methods of surveying and digging, assaying ores, smelting, and mining that were still credible when Jamestown was founded. It demonstrates that the Virginia colonists and officials had access to or at least acquaintance with a well-developed body of knowledge connected with mining and metallurgy. Agricola's published work brought mining and metallurgy from an arcane science passed from father to son to a more universally understood and technically based discipline. The spread of these related ideas and information had already made an impact on England's economy, defensibility and thirst for exploration.

Agricola's first work on mining (1530) influenced the master Italian smelter, ironworker and mining engineer, Vannoccio Biringuccio. He wrote "The Pyrotechnia" (1540) a treatise that became the first printed book on the metal arts and metallurgy and a significant influence on both until the end of the eighteenth century. Eschewing necromancy as a dependable tool in mineral prospecting and metallurgy, Biringuccio advised the following, which foreshadows English mine-seeking efforts in Virginia:

> ...It is necessary to walk around, making certain from the appearance of the signs (trying to find as many as possible) and always keeping eyes and ears turned to wherever there is hope of finding some information, especially toward shepherds or other ancient inhabitants of the countryside. (Biringuccio 1540/1990, Gnudi Trans., p. 14)

Biringuccio's instructions foreshadow the extensive efforts of English explorers, colonizers, and mineral men (prospectors) to engage native people in information exchanges as the "ancient inhabitants" of Virginia. (Similar practices are still incorporated into modern geologic fieldwork.) In the same way, the call for direct observation suggests a separation from the supernatural aspects of alchemy, an expression of natural history in development.

ENGLAND ENTERS THE SCENE

The sixteenth century began with England lagging behind other nations in mining and mineral development. Henry VIII recognized the need to develop lead and iron mining in Wales. Because of the demand for brass and iron for English artillery production, metal prospecting and the skill to smelt copper to make bronze for cannons were seen as vital by the crown. German technical skills were essential if England was to cease relying on the importation of copper and gun-makers for manufacturing ordnance, or worse, importing the cannons themselves (Rees, 1967). Queen Elizabeth I succeeded in importing German miners and metallurgists to recoin currency that had become debased, to train English workers on a higher level in mining and metallurgy, and to support organized monopolies to search for metals in her realm (Grassl, 1993).

Under the Germans, industrial operations were greatly expanded in England. New metal sources were found within the nation and mining operations went deeper into the earth than ever before with more sophisticated technology - such as water pumps - available to English and Welsh miners. At the same time, English promoters, privateers, and explorers opened the path to the New World. Among them were Sir Martin Frobisher and Sir Walter Ralegh, whose

efforts foreshadowed English colonial ventures after 1600. By 1568, two mineral development monopolies had been formally incorporated: The Society of the Mines Royal and The Governors, Merchants and Society of the Mineral and Battery Works (Grassl, 1993). The primary function of the Society of Mines Royal was to mine and smelt copper and lead ores. Joachim Gans, a German mineral specialist, did assay work for the Society in 1581 before sailing to Roanoke in 1585 (Grassl, 1993).

In examining the cultural underpinnings of mineral exploration and metallurgy, the role of alchemy should not be underestimated. Although it was simultaneously a philosophy of the universe and an experimental science, the transmutation of metals has become a historical "sound bite" for a much larger and complex body of knowledge. Alchemists sought to satisfy "their material needs, their intellectual capacities, and their spiritual yearnings" (J. G. Parr as cited in Marks and Beatty, 1975, p. 29). The essence of early alchemy was a belief that different metals represented stages of evolution as the metals "ripened" in the earth into the purest metal, gold. Physicians between the fifteenth and nineteenth centuries used both common metals (zinc, tin, iron, lead, manganese, and nickel) and precious or noble metals (gold and silver) as medicinal ingredients. Astrology connected metals to parts of the body: silver, associated with the head, was used as an ingredient in treating mental and cerebral diseases (Marks and Beatty, 1975).

Dr. John Dee (1527-1608), like the times he lived in, blurred the line between science and the supernatural. A learned geographer, mathematician, alchemist, and occultist, Dee was philosopher to Queen Elizabeth and taught Martin Frobisher and other naval captains the mathematical art of navigation. In a 1577 proposal written for the queen's Privy Council, Dee envisioned England's expansion as an empire with Queen Elizabeth the monarch ruling over all its territories. He predicted that rich mines would be found as the English explored the northern reaches of North America and found a route to Asia.

"Meta Incognita," or the Unknown Shore, was Queen Elizabeth's name for the Canadian Arctic. Martin Frobisher explored this area during three voyages between 1576 to 1578. At first searching for the Northwest Passage, his second and third voyages were part of a "gold rush" based on the misidentification of glittering particles in an ore sample. However, of the first four assayers who tested pieces of the original stone sample, three correctly said that there was too little gold to warrant mining it (Ruby, 2001). Major scientific and archaeological studies of England's Arctic Colony have shown that the black hornblende ore found there also contained biotite, a variety of mica, that gleams like gold when oxidized or heated.

Kamaiyuk, an Inuit village site near the Countess of Warwick Sound, was an early contact site described in 1577 by Frobisher's lieutenant George Best. Slag-encrusted crucible fragments were among the artifacts found there. Kodlunarn Island, explored in 1577, was a base camp in 1578. The island has yielded artifacts representative of both blacksmithing and assaying activities (Auger and others, 1995). Questions have arisen regarding the field assay operation of 1578 as to why testing conducted before shipping twelve tons of ore did not prevent shipping it or at least raise doubts as to its worth. Possibly inadequate test results were generated when samples were contaminated by the lead used to separate gold and silver from the matrix.

The queen supported Frobisher's second and third expeditions after one of several assayers found promising amounts of gold in the ore samples. The second voyage in 1577 returned 160 tons of ore from one mine (the Countess of Warwick Mine, on modern-day Kodlurnan Is-

land) and resulted in the construction of the largest blast furnace in England. The third voyage, a huge undertaking of 15 ships and 400 men in 1578, conveyed almost 2,000 tons of ore to England.

One hundred forty-seven men were recruited as miners and would work seven mines of which only two, the Countess of Warwick and the Countess of Sussex (located in Frobisher Bay on a small peninsula), are firmly established (Hogarth, 1983). Modern archeological evidence for assaying activity discovered on Kodlurnan Island includes scorched brick, broken crucibles, and partly fused rock. Hogarth presents other documentation, including bills of lading for the second and third voyages, showing detailed lists of mining equipment.

Frobisher's effort has often been marginalized, much as colonial mineral exploration in Jamestown has generally been dismissed. However, Smithsonian-sponsored geologic research by Donald Hogarth and others between 1981 and 1991 identified and documented over half of the mine sites and provided interesting new data on the true nature of the ore Frobisher described. Rather than iron pyrite, small flecks of biotite mica oxidized among black hornblende crystals when the ore was heated. Further, the ore does contain gold, but not in a concentration worth mining.

Extensive information, including lists of mining equipment taken on the second and third expeditions, show that mining methods relied primarily on crowbars, sledges, wedges, pickaxes, and manpower to excavate the hard rock in open pits. The mines were simply abandoned whenever the rock proved too hard to excavate (Hogarth, 1983).

Technical support was provided by English and Welsh miners and "goldfiners" (assayers), with two German metallurgists and a London goldsmith in the second voyage and with similar expertise on a larger scale in the third. It took more than two years to determine that the ore was worthless, its gold content possibly linked to assayers either deliberately or inadvertently introducing additives in the assay process (Symons, 1999). Despite the resulting financial disaster for investors, Frobisher was exonerated. He was knighted at sea as a naval commander during defeat of the Spanish Armada in 1588.

English mineral exploration in the New World continued under the auspices of Sir Walter Ralegh, sponsor of several voyages and colonizing attempts between 1584 and 1590 in what is now North Carolina. Ralegh followed in the path of his half-brother Sir Humphrey Gilbert, who was the first Englishman to promote active colonization with discovery of gold and silver as a primary goal. Master Daniel the Saxon, a mineral specialist and refiner from Saxony, was listed in the expedition, and English exploration chronicler Richard Hakluyt wrote that Daniel had found iron and silver-bearing ore before perishing in a storm at sea with his shipmates (Grassl, 1993; Hakluyt 1906, as cited in Burrage, 1930). Gilbert followed John Cabot's 1496 and 1497 voyages to North America with Bristol ships and crews: Cabot, a Genoese, claimed the land he discovered (northern New England) for the crown of England (Sauer, 1971). Sir Humphrey Gilbert claimed Newfoundland for England in 1583 before his frigate sank on the return voyage. Edward Hayes captained "The Golden Hind" for Gilbert and made a report printed in 1589: "We were in number in all about 260 men...also mineral men and refiners..." (Wright, 1965, pp. 82-83).

In the field of exploration literature, Richard Hakluyt contributed a significant work, "The Principal Navigations, Voiages [sic] and Discoveries of the English nation." Expanded later in three volumes published in 1598, 1599, and 1600, it includes an insight into Master Daniel the Saxon's job security:

> Who after search brought at first some sort of Ore, seeming rather to be yron then other mettal. The next time he [Master Daniel] found Ore, which with no small shew of contentment he delivered unto the General, using protestation, that if silver were the thing that might satisfy the Generall and his followers, there it was, advising him to seeke no further: the perill whereof he undertooke upon his life (as deare unto him as the Crowne of England unto her Majestie, that I may use his owne words) if it fell not out accordingly (Hakluyt, 1906, as cited in Burrage, Ed. 1930).

In 1584, Ralegh obtained a patent from the Queen transferring his deceased relative Humphrey Gilbert's land rights in North America to him. Ralegh had aggressively sought out information and expert opinion for founding an English colony in America (Milton, 2000). One of the most important intellectual assets and friends he had was Thomas Hariot, the scientist and mathematician who taught Ralegh's pilots the navigation and mathematics skills needed to reach the New World.

Bohemian mineral expert Joachim Gans was also instrumental in the quest for precious metals. Following Hariot's role as expedition scientist, his seminal English contribution to the literature of New World exploration, "A Briefe and True Report of the New Found Land of Virginia" was first published in 1588 and printed again in 1590 by Theodor de Bry with illustrations by John White. De Bry commissioned botanist Charles de l'Écluse to translate it into Latin and French and more than seventeen printings were made in the next quarter-century (Rowse, 1959; Hariot, 1972). Hariot gave valuable and detailed information on the flora, fauna and native inhabitants of the Carolina Outer Banks, yet his perspective was keyed to the area's economic possibilities. Some descriptive terms he uses are unfamiliar in modern times: "Roche Allum," (double sulphate of aluminum and potassium) "White Copresse," (protosulphate of zinc) "Nitrum," (potassium nitrate) "Alumen Plumenum," (plume or feather alum) and "Wapeih" ("very like to terra sigillata," a clay), in addition to iron, copper, and silver (Hariot 1590, as cited in Quinn, 1991, vol. I, 327-328). Hariot lists locations for all of the above and mentions that the "aforesaide copper wee also founde by trialle to holde silver." Also, ore tested "by the triall of a minerall man, was found to holde yron richly" (Quinn, 1991, vol. I, pp. 331-333). Hariot also interviewed the "naturall inhabitants" for information, noting that "wapeih" had been refined and found by some of our Phisitos and Chirurgeons to be of the same kinde of vertue and more effectuall" than Terra Sigillata, similarly discovered and earmarked as a commodity by Jamestown explorers (Quinn, 1991, vol. I, p. 328).

In "The Roanoke Voyages," David Beers Quinn analyzed Hariot's mineral commodities observations according to the known geology of North Carolina. Quinn noted there was no alum in the coastal clays of North Carolina, although iron and bog iron could be found in swamp forests, and marshes and along the Roanoke and Chowan riverbanks. According to Quinn, natural silver was also rare in eastern North America and he doubted that white copperas (protosulphate of zinc) had been located, although copperas (iron sulphate) was possibly identified (Quinn, 1991; J.W. Miller, personal communication, September 2, 2004).

Proficient in understanding and speaking Algonquin dialects with the native inhabitants of the Outer Banks, Hariot wrote of their interest in English objects:

> Most things they saw with us, as Mathematicall instruments, sea Compasses, the vertue

> of the lodestone in drawing yron, a perspective glasse whereby was shewed many strange sights, burning glasses, wildefire workes, gunnes, bookes, writing and reading, spring clockes that seems to go of themselves, and many other things that we had, were so strange unto them, and so farre exceeded their capacities to comprehend the reason and meanes how they should be made and done, that they thought they were rather the workes of gods then of men (Hariot, 1590/1972, p. 27).

The supernatural element underlying each of these cultures in the Contact period is significant to understanding the acclimatization then taking place. Although the learning curve is not an adaptation of technology in the modern sense, first impressions of English "workes of gods" indeed changed as native people became more familiar with their use. At what points of cultural interaction did these native observers realize that they could share in the power of such objects, given the opportunity? At what point did they separate supernatural authority from objects of daily or specialized use?

The exchange of information across cultures and subsequent intellectual and material modifications is easier to trace from the English perspective. It is the dominant voice of colonization and does not reflect the indigenous peoples' response. Although much of the data on natural and human resources by Hariot has not survived, his published report indicates a deep interest in native culture and knowledge about the material world, as well as native beliefs.

Expedition artist John White, scientist Thomas Hariot, and mineral expert Joachim Gans accumulated written notes and drawings between July, 1585, and June, 1586. They mapped the region between the Neuse and James rivers as far inland as the head of the Albemarle Sound. They traveled and wintered in modern-day Norfolk, Lynnhaven Bay, and Cape Henry, and added immeasurably to the English understanding of the New World both then and for future colonization (Quinn and Quinn, 1995).

Unlike many other expedition members who came for adventure and wealth, Hariot and Gans methodically inventoried the region's natural resources for England's benefit (and probably Sir Walter Ralegh as owner under the crown of these North America property rights). Similarly, Gilbert's assayer, Master Daniel the Saxon, had a portable assay furnace onboard the *Delight* before it sank off Sable Island, 300 km southeast of Halifax, Nova Scotia, Canada. An assaying building was identified as part of the Frobisher expedition archaeological project. Frobisher's assayer Jonas Schultz may have also brought a portable assay furnace (Grassl, 1993, p. 87). These actions point to systematic procedures in use by the English in mineral exploration on the frontier.

At Roanoke, Governor Ralph Lane detailed available native information about potential minerals and mines of Chaunis Temoatan, where copper and gold might be found. Its inhabitants, capable of smelting metal, lived in a province beyond the "Magoaks," who may have been an Iroquian tribe living between the Roanoke and Chowan Rivers (Quinn, 1991). David Beers Quinn has theorized that Chaunis Temoatan, the fabulous copper mine, may have been the stuff of native legend, based on large exposed copper nodes found in the Appalachian mountain range near the Roanoke River basin (J.W. Miller, personal communication, September 2, 2004).

Geologist J. William Miller, Jr., professor of environmental sciences at the University of North Carolina-Asheville, notes the presence of large copper deposits in the Appalachians to the west of the Roanoke River; however, he knows of no such copper deposits near the Roanoke River basin. All of the copper production in Virginia and North Carolina is from copper com-

pounds (Sweet, 1989, p. 1-5), with no production coming from native copper (metallic copper Cu, found in its elemental state), such as from the Keewenaw Peninsula of Michigan (J.W. Miller, personal communication, September 2, 2004).

Such was the case at Jamestown. Initial testing of the ore was important to knowing the potential of promising ore deposits. In 1849, a visitor reported finding "glass globes containing quicksilver and hermetically sealed" (Hume, 1994, and personal communication, November 3, 2004). Sir Walter Ralegh described testing equipment used by his contemporaries: in "The Creature in the Map: Sir Walter Ralegh's Quest for El Dorado" Charles Nicholl (1995) includes Ralegh's account of surprising some Spaniards in Guiana. Ralegh described an Indian basket containing a gold refiner's kit that was found abandoned in the bushes: "I found in it his quicksilver, salt-petre and divers things for the trial of metals," as well as the dust of "such ore as he had refined" (Nicholl, 1995, p. 57).

According to William Kelso, who worked on the Roanoke excavation in the early 1990s, no actual workshop site was found, only the crucible fragments and distilling evidence. (Personal correspondence, July 23, 2004). On Roanoke Island, twentieth-century archaeological work uncovered earthworks and artifacts through the archaeological projects headed by Jean C. "Pinky" Harrington and Ivor Noël Hume. Assay work was conducted on Carolina ore on Roanoke Island as documented by over one hundred artifacts found (including crucibles, delftware drug pots, chemical glassware, worked and unworked copper, and antimony – used to separate silver from copper) during the 1990s excavations led by Ivor Noël Hume.

Archaeologist Nicholas Luccketti, who also worked at the Roanoke excavation with Hume and Kelso, notes that these artifacts and similar materials recovered in earlier excavations all point to distilling and assaying by Hariot and Gans during the 1585-1586 colonization effort (Luccketti, personal communication, September 23, 2004, lecture text 1998; Kelso, personal communication, July 23, 2004). It is likely that miners and soldiers assisted metallurgist and mining engineer, Joachim Gans, in his experiments and explorations. However, the colonists' search for gold in modern-day North Carolina was ill-fated. Hariot criticized "the many that after gold and silver was not so soone found, as it was by them looked for, had little or no care of any other thing but to pamper their bellies" (Hariot, 1590/1972, p. 6) Although gold was not found in the seventeenth century, in 1799 a 17-pound gold nugget was discovered in Carbarrus County near Charlotte, North Carolina, and the property where it was found yielded an estimated $100,000 in gold by 1824. From the early-to mid-nineteenth century the Charlotte area was the second leading producer behind California of gold in the nation with an average of one million dollars annually (Alexander, 2004).

Roanoke was not Ralegh's only quest for mineral resources. In 1595, Ralegh implemented a plan to exploit iron ore found on his Irish estates by mining it, licensing the building of a smelting-works and the felling of timber for fuel (Nicholl, 1995). That year, Nicholl found, he also led an expedition up the Orinoco River in Guiana to look for El Dorado, the city of gold, writing extensively of his findings and technical preparations. They sound remarkably similar to the types of physical descriptions that John Smith would make in Virginia, noting land topography and locations of soils, rocks, and minerals, or Hariot's observations on the Outer Banks. According to the calculations of Ralegh's map, El Dorado lay on the banks of a lake "eleven days" march from the Orinoco River. In Spanish expeditions of the period, a day's march covered five leagues, equivalent to 15 miles. In his 1596 work

"The Discoverie of the Large, Rich and Beautiful Empyre of Guiana, with a Relation of the Great and Golden Citie of Manoa" (which the Spaniards call El Dorado), Ralegh identified mineral deposits. He also described the limited industrial resources available in Guiana: "whosoever hath seen with what strength of stone the best gold is environed, he will not think it is easy to be had in heaps" (Nicholl, 1995, p. 197).

More valuable details are found in Ralegh's 1612 proposal for another voyage. The supply list included a smith's forge, bricks for a furnace, refining equipment, pickaxes, spades, crowbars, and baskets lined with leather in which to carry ore from the mine to the river for transport (Strathman, 1964). In an interesting economic comparison to native labor costs in Virginia, William Strachey reported in "The Historie of Travell into Virginia Britannia") (1612) that in Guiana one hatchet would buy the services of thirty natives with a canoe for one month, and a three-penny knife would buy "a hundred weight of good biscuitt" (Strachey as cited in Wright and Freud, 1953, p. 93).

Ralegh's quest ended with his 1618 execution following long imprisonment in the Tower of London as punishment for allegedly planning James I's overthrow. Ironically, although they were not exploited successfully by Ralegh, gold deposits are found in Guiana just as they are in Virginia, both in deposits with quartz (Ralegh's white spar) and in gravels and river beds. In his account of replicating the Ralegh expedition in Guiana in 1992, Charles Nicholl dates isolated gold prospecting to late 1595. In a false start, Mexican miners located what turned out to be iron pyrite in the foothills of the Guiana Highlands before gold was ultimately discovered north of the Yuari River in 1857. Ralegh was not alone in influencing future exploration: in 1602, when Ralegh sent Samuel Mace to explore and search for surviving members of the 1587 settlement, Hariot had sent Mace advice for the voyage in a memorandum. Hariot detailed instructions on the procurement and preparation of copper circles and squares of specific numbers and sizes for trade with the natives, although it is not known if Mace followed through (Quinn, 1990; Quinn, 1970).

Jeffrey P. Brain, chief archaeologist for the Popham Project, heads the ongoing excavation of Jamestown's "lost twin" in modern-day Maine (Figure 4). Paralleling the founding of Jamestown, English backers looked north to Maine for exploitable furs and minerals. Established by the April 10, 1606, charter forming the Virginia Company (West-Country branch), two ships left Plymouth, England in May 1607 with more than one hundred colonists led by George Popham, landing in August 1607. The principal

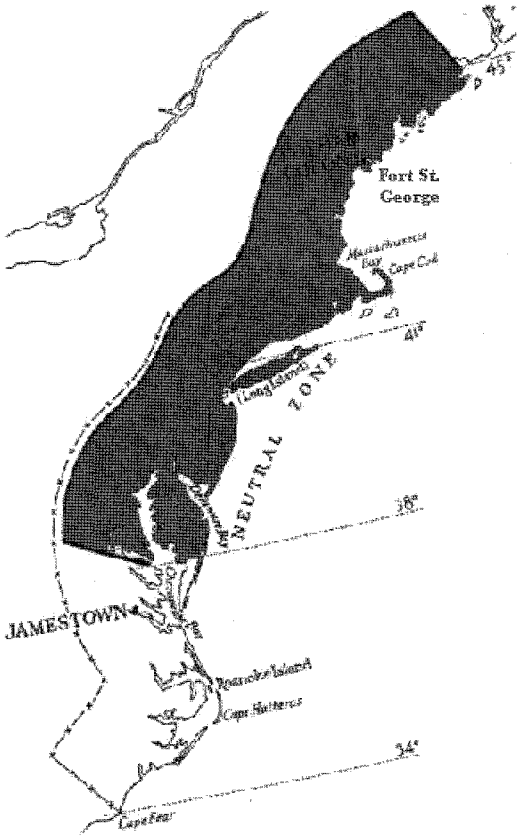

Figure 4. The Popham Colony, or the Northern or Second Colony, (shaded gray) was planted at the mouth of the Sagadahoc River, today's Kennebec River in the State of Maine (from Brain, 2001).

settlement was Fort St. George on the Sagadohoc (today's Kennebec) River. Gome Carew, identified as one of the "Gentlemen of Quality" and "the "Chief Searcher (for mines)," may have been an alchemist.

A map drawn onsite by one of the colonists before the colony was abandoned in the fall of 1608 shows the presence, or plan for, a blacksmith's house and possibly, an attached workshop or forge. The Hunt map shows eighteen buildings, and if the Popham site is further excavated, archaeologists may learn how many were actually constructed (Brain, 2001).

As a contemporaneous settlement to Jamestown, Fort St. George offers further understanding of the English colonial mindset including similar processes in mineral exploration. As of the 2004 archaeological season, no artifacts have been identified as relating to metalworking or refining. The Popham Colony leaders did not mention the same kinds of activities and explorations documented for Roanoke and Jamestown, but a December 1607 letter written to the Earl of Salisbury by Sir Ferdinando Gorges is part of extant correspondence relaying news of the colony. In this letter, Gorges assesses the "Kennebec colony" commodities, noting: "As for mettals, they can say nothinge, but they ar confidente there is in the Contry, if they had meanes to seeke for it, neither could they go so high, as the Allom mines ar, which the Sauages doth ashure them there is great plenty of" (Quinn and Quinn, 1983, p. 448). It appears that in both the Maine and Virginia colonies, natives and colonists interacted concerning identification and location of mineral resources.

PRECONTACT TO CONTACT: THE VIRGINIANS AND THE ENGLISH

When English investors and adventurers combined forces to prepare for the first voyage to Jamestown, the travelers' agendas must have ranged from selfish to nationalistic with many shades between. Expectations and experience levels varied, but one constant may have been the "shopping list" of commodities authorities expected to find. Such a specific list does not appear in Virginia Company documents, but shows up indirectly between the lines of detailed descriptions made by Archer, Smith, Strachey, and others. References repeatedly made to Terra Sigillata, Mastick, Alum, Salsa Perilla, and Bolus, unfamiliar terms until one consults the "Oxford English Dictionary" for their seventeenth-century meanings. Contemporary sources provide a roadmap to the use and value of these substances. In his 1612 "Historie," Strachey referred to Dr. Lawrence Bohun, who came to Virginia in 1610 as the first physician appointed by the Virginia Company. In addition to his expertise in medical botany, Bohun may have directed or suggested how the colonists proceeded to look for medicinal clays in the natural *pharmacopeia* in which they found themselves (Stearns, 1970). Such clays, ingested like a modern antidiarrheal, could relieve debilitating diarrhea and were prescribed in England for such intestinal afflictions. Dr. Bohun discovered and named "*Terra Alba Virginensis*," a Virginia white clay that promised poison expelling and absorbent properties that would help pestilent and malignant fevers (Blanton, 1930).

Bohun was not the only forward-thinking physician connected in some way with Jamestown and the London Company, Dr. Wyndham Blanton explains. Among the medical men who were subscribers in the Company were Peter Turner, physician to Sir Walter Ralegh in the Tower, John Woodall, author of "The Surgion's Mate," [1617] and Thomas Hood, who traveled with Sir Walter Drake in his explorations.

In "The Admirable Secrets of Physicke

and Chyrurgery" by Thomas Palmer in 1696 (Forbes, 1984), a young Massachusetts practitioner, other earth-based materials are listed for their healing properties. In the prevailing system of the time, an illness under treatment fit into one of several categories of humours: a perceived hot, moist condition such as dysentery, heart disease, or gangrene would be treated with cool and drying cures, clay being a valuable curative. Bole Armoniac was red clay, with "bole" meaning a bolus or mass, mixed with other ingredients to treat "moist distempers of the heart," infections of the lungs, and even eye inflammations. Mas-

ticks were tree gums or resins used in the treatment of dyspepsia, dysentery, and gout. Terra Lemnia or Sigillata was "the sovereign minerall against infections," according to a 1632 reference in the "Oxford English Dictionary." An "Oxford English Dictionary" 1802 reference continues, "This earth {of Lemnos}...is called Terra Sigillata, being formed into small loaves sealed with the grand seigneur's seal, and thus dispersed over various parts of Europe." Turkey, Armenia and Italy were known for exporting Terra Sigillata, Bole Armoniac, and Roach (Romish) Alum respectively. The 1621 export value of similar

Figure 5. John Smith's "Virginia" was separately published in London in 1612 and was also included in the Oxford publication of John Smith's *A Map of Virginia: With a Description of the Countrey, the Commodities, People, Government and Religion [1612]* (Courtesy of The Colonial Williamsburg Foundation).

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resources in Virginia included Mastick at three shillings the pound; Red Allum, called Carthegena Allum, and also Roach Allum (alum or allum is potassium aluminum sulphate, an astringent), both ten shillings the hundred (Force, 1999, vol. III).

Smith's "Map of Virginia" (Figure 5) demonstrates the link between geological observation and such commodities: "The Colour of the earth we found in diverse places, resembleth *bole Armoniac, terra sigillata and lemnia,* Fuller's earth [a variety of earth used in cleaning and scouring woven cloth to remove oil and grease] marle, and divers others such appearances" (J. Smith as cited in Barbour, 1967, Vol. 1, p. 145). In such statements, Smith and other colonial reporters not only helped readers to connect through familiar cultural references, but also apprised them of Virginia's potential in mineral resources.

The first permanent English colony in North America took hold through such commodification and possession of the landscape, but what of the culture it displaced? In 1607 when the English landed, they were in the midst of the powerful Powhatan chiefdom of an estimated 13,000 to 15,000 people, spread over some 6,000 square miles of Virginia's coastal plain. It has been designated through the centuries by the birthplace name of its ruler Wahunsonacaugh, father of Pocahontas, and *mamanatowick* (paramount chief), of over 30 tribes. A portrait of the Southern Algonkians partially emerges from several sources: 1) the documentation of English artist John White; 2) the accounts of early explorers such as Thomas Hariot (both White and Hariot traveled to the Chesapeake Bay area as part of the 1585 expedition to found the ill-fated Roanoke Colony), and 3) modern archaeological evidence in Southeastern Virginia. In "A Briefe and True Report of the New Found Land of Virginia" (1590), Hariot wrote that although the native people lacked the tools, crafts, sciences, and arts of the English, "yet in those things they do, they show excellency of wit" (Hariot 1590/1972, p. 25). Another source, however, is invaluable. Later English observers who, despite cultural biases, provide important clues. These clues showed how Powhatan technical processes and preferences (particularly related to tools) would change after 1607, when the first English settlers landed on Jamestown Island. Before any contact with Europeans or their trade goods, Powhatans extracted the materials they needed from their immediate environment, and traded or traveled to obtain other natural resources they desired. From the woods and water, they gathered stone, bone, shells, plant fibers, and wood, as well as food to supplement the crops they grew. Skillful use of fire enabled them to char, scrape, and thus modify hard woods for woodworking.

Copper has been recognized by modern scholars and archaeologists as one of the ornamental or exotic Indian commodities. Daniel Richter described copper as conferring rarity and great significance to those who acquired them, esteemed in long-distance reciprocal exchanges, and found often as grave goods (Richter, 2001). Both Powhatans and the Indians of the Outer Banks of North Carolina wore and valued copper, according to English explorers. These native cultures lacked pyro-technology and the ability to smelt or cast metal. Thus, they did not develop copper alloys for efficient metal weapons and tools. For the Powhatan Indians, copper sources included native trade from the Great Lakes area, European visitors, and later the Jamestown colonists. In Virginia, most native copper is located in the Greenstone units in the Blue Ridge province west of the Monacan Indians in the western Piedmont province. Purest native copper has been found in the Blue Ridge Mountains of Virginia in the Dark Hollow mine (Madison County), Hightop mine (Greene County), and Allen mine

(Nelson County) (Sweet, 1989). Jeffrey Hantman (1993) proposed in "Powhatan's Relations with the Monacan Indians" that the Powhatans also utilized Monacan copper sources. In 1607, colonist Gabriel Archer described a Powhatan-English interaction in which a petty chief made the claim that the Powhatans used native copper in Monacan territory (Figure 6). He also noted that whether the Monacans were miners, middlemen in a copper trade chain, or both, copper was

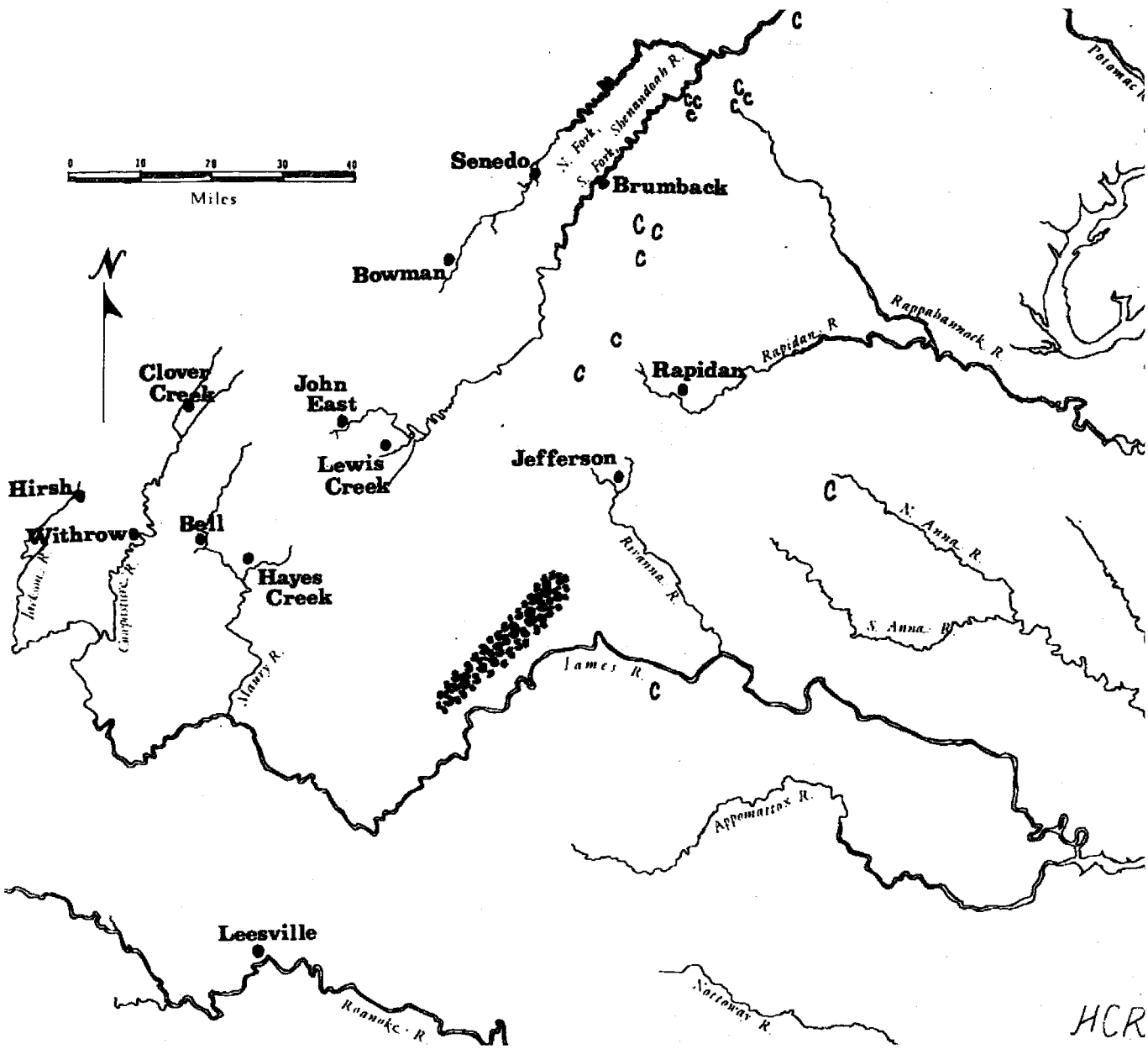

Figure 6. Sites of burial grounds and archeological sites producing native copper (C) in the Virginia Piedmont, Blue Ridge, and Valley and Ridge provinces (from Rountree, 1993).

spiritually and economically charged and important to Indian regional prestige (Rountree, 1993). It is likely that the Powhatans shaped vein copper into tube beads and other desired forms by annealing it, a simpler method that does not require smelting (Heuvel and Veneziano, 1999).

Vein copper, such as is found in the Great Lakes region, is of purer quality and more malleable than ore copper. Studies of native copper use and metallurgy in prehistoric northeastern North America by Amelia M. Trevelyan point to a sophisticated and complex use of native copper for ritual use and a "copper elite." Data gathered in ancient mining works in the Lake Superior region show that Precontact mining practices were primarily governed by spiritual rather than economic considerations. Accumulated archaeological evidence from hundreds of mines in the Great Lakes region indicates that the miners were capable of working and moving large masses of copper but generally worked only in small veins ¼ to ½" deep, possibly for ritual reasons (Trevelyan, 2003).

Copper's importance in the lower Chesapeake is also substantiated by archaeological evidence. The summer 2004 announcement of archaeological findings at Kiskiack, the Powhatan Indian village site now surrounded by the Naval Weapons Station at Yorktown, Virginia, has significant implications for the study of copper usage in the Chesapeake region. Archaeological evidence from the Kiskiack context established the presence of trade copper in Indian middens rather than native burial sites. This is possibly indicative of a major devaluation in copper's spiritual and economic value among Powhatans once an uncontrolled English copper trade glutted the native market, a trend previously presented by Seth Mallios and Stephen Potter (Blanton and Hudgins, 2004). Advanced chemical analysis by Carter Christian Hudgins of copper artifacts from Jamestown and Kiskiack definitely ties the Kiskiack copper artifacts to the English. The chemical analysis has helped to define copper trade and distribution in the Contact period.

Although the colonists did not identify the Powhatan Indians as miners, mining activity was observed elsewhere. To the north near the Potomac River, antimony was mined and washed free of impurities by Patawomeck natives, then traded as a commodity to other Virginia tribes as decoration (Bruce, 1935). From the Blue Ridge Mountains of Virginia, the Powhatan Indians gathered or traded for Catoctin greenstone (a metabasaltic stone) from the Blue Ridge Mountains to polish into celts for stone axes. They were limited by a geologic shortage of stone and ore in the Virginia coastal plain they inhabited (Rountree, 1990). Steatite, or soapstone, was valued in the Archaic Period for making vessels. After the advent of pottery, steatite was still used to carve objects such as pipe bowls. Cutting tools ranged from those fabricated of easily obtainable quartz, quartzite, or deer bone to sharpened reeds and shells. However, the material objects they made were not static in use or design over time. As with other Indian cultures, they changed as the Powhatan people's needs and desires changed within their own culture, and after prolonged contact with English culture (Egloff and Woodward, 1992). Keith Egloff, assistant curator with the Virginia Department of Historic Resources and co-author of "First People: The Early Indians of Virginia," has noted that changes in culture do not occur evenly. In comparison to religion, which normally changes slowly, or government, technology tends to change at a faster rate (Egloff, personal communication, June 1, 1999).

It is clear from primary English sources such as John Smith and William Strachey that the Powhatans observed and absorbed the colonists' uses of metal. The Powhatans' desire for metal tools, firearms, and other trade items, together with the English desire for food and information,

fueled their early interaction with each other. Timothy Silver's conclusions in "A New Face on the Countryside: Indians, colonists, and slaves in South Atlantic forests, 1500-1800," point to ecological change not simply as an irrevocable result of European arrival, but as a series of changing cultural and economic relationships between three successive cultures, Indian, European, and African, and the land. Silver's "new face on the countryside," created by early colonization, was prefaced by native use of the land and changed by the use of slave labor in South Atlantic agriculture (Silver, 1990).

The English desire for precious metals, among other commodities, was matched by the Powhatans' equal desire for processed copper among other trade goods. Amelia Trevelyan's analysis of English descriptions of Wahunsonacaugh (or Powhatan), his people, and the ways they used copper suggests that copper was spiritually vital to their well being as a society. An elite kin group led by Wahunsonacaugh in his role as priest and leader may have ceremonially governed the use of copper (Trevelyan, 2003). In his article "Breaking into the Backcountry: New Approaches to the Early American Frontier," Gregory Nobles maintains that the English elite sought to shape the frontier "to fit their social vision and economic interests" (Nobles, 1989, p. 643). The dynamics of supply and demand existed on both sides, i.e. the metals valued by the English could enrich individuals as well as investors; similarly, Powhatan men and women of lower standing than the chiefly class traded goods and services with sailors and other colonists without sanction of their leaders (Potter, 1989).

Stephen R. Potter (1989) has theorized that during the early Contact Period, the Algonquian chiefs or werowances attempted to control the flow of trade goods from the English as they did the flow of tribute from their own people. Copper was perceived as a high prestige trade good and as private trade and official trade inflated the amount of copper within the Powhatan economy, its value diminished, affecting the chiefly hierarchy's prestige. As trade and interaction continued, copper receded in importance. In his essay "North American Natives Responses to Europeans: Romantic Versus Rationalistic interpretations," Bruce Trigger proposed that in reacting to Europeans, native groups eventually overcame an initial belief that Europeans possessed supernatural powers and came to re-evaluate them as human beings with whom they would trade and interact within recognized cultural perimeters (Kupperman, 2000). Karen Ordahl Kupperman (2000) noted in "Major Problems in American History" that desired trade goods evolved from those immediately recognizable and useable within the native communities, i.e., copper and beads, to those showing increasing degrees of cultural adaptation, such as metal tools and cloth.

It can be inferred that in addition to the guide services offered officially by the mamanatowick Powhatan and his chiefs, other knowledge and technical transfers took place through interpreters (both English and native) and other cultural contact points, many involving metals and minerals as well as native flora and fauna. In "A True Relation," John Smith described a 1608 interaction in which "a Paspaheyan came to show us a glistering mineral stone and with signs demonstrating it to be in great abundance like some rocks" (J. Smith as cited in Barbour, 1986, Vol. I, p. 93). Smith and a dozen men accompanied the Indian, whose behavior convinced Smith that it was either a potential ambush or a trick to get valuable copper. As a punishment, the suspicious English leader displayed some copper the guide would have received had he been trustworthy. Smith then "gave him twentie lashes with a Rope, and his bowes and arrowes, bidding him shoote if he durst, and so let him goe" (J. Smith

as cited in Barbour, 1986, Vol. I, p. 93). This account and another involving the Powhatan Indian guide Namontack suggest other mineral-related cultural interactions took place.

During the transition from the initial Virginia gold rush to realization of economic viability through tobacco, expectations for commodities and industry kept resources flowing to the colony from overseas. In his New England exploration, John Smith continued to make geologic references pertaining to the land and its promise. Despite his oft-quoted comments about gold-related activities in the early Jamestown colony, Smith continued to inform readers of potential mineral resources in his New England descriptions and noted that he was no alchemist, nor did he have a "mineral man" with him to verify his identifications of clays, stone and other mineral resources (Stearns, 1970).

THE JAMESTOWN STORY

"But the worst was our guilded refiners with their golden promises made all men their slaves in hope of recompences; there was no talke, no hope, no worke, but dig gold, wash gold, refine gold, load gold..." (Smith as cited in Barbour, 1967, vol. II, pp. 247-248). It is tempting to target this passage by John Smith as a condemnation of mineral exploration in the colony and the ineptness of its organizers. However, taking words out of context may alter their meaning and significance. The colonial Virginia context unfortunately has gaping holes due to loss of written English records and the lack of written documentation for the native population. Analyzing context involves studying as much credible information as possible and also comparing circumstances and actions that appear to have similarities. The historical accounts previously outlined show that an exceptional body of practical knowledge on geography, previous exploration, and technology accompanied the English to Jamestown.

Both Ralegh and Hariot still lived, and substantial exploration literature, most of it lost to modern scholars, was still probably read and discussed by investors and officials connected to the Virginia Company's plans. In addition, natives from Roanoke and later South America played a key role in providing a linguistic and information bridge when Ralegh took them back to England between 1584 and 1618. Alden T. Vaughan (2002) provided in-depth information on as many as twenty natives (beyond the well-known pair Manteo and Wanchese) who were "gently" indoctrinated into English speech and customs by Ralegh and Hariot during Ralegh's prime expeditionary phase. These natives subsequently acted as expedition translators.

Based on exploration literature circulating in Europe, the English could easily have believed that finding precious metals or stones would require little effort. Carole Shammas developed this thesis in her 1978 essay on English commercial development and American colonization between 1560 and 1620. She noted that anyone who had read a translated account of Spanish colonization in America might have assumed that a relatively small number of Englishmen could accomplish the same type of conquest and access to vast riches via a subdued native population.

A thorough reading of John Smith's writings (for both Virginia and New England) shows his ability, like Ralegh's, to observe and analyze his physical surroundings for their mineral potential. Smith was concerned with problems of provisioning and productivity. He was also concerned that local metallurgical testing, which he was not allowed to observe, possibly for political reasons or artisanal secrecy, was inadequate. Perhaps gold fever might be overriding a more rational approach to governance and exploration, both

legitimate concerns. "Were it that Smith would not applaud all those golden inventions because they admitted him not to the sight of their trials nor golden consultations, I know not. But I have heard him oft question with Captain Martin, and tell him, except he could show him a more substantial trial, he was not enamoured with their 'dirty' skill..." (Barbour, 1967, vol. II, pp. 247-248).

Gold is concentrated as a product of volcanic or hydrothermal activity. Geologically, it may be found as "free gold" in quartz veins, with pyrite, or as gold that has been eroded and redeposited in sediments in placer deposits. Iron pyrite (fool's gold) may have been present as small bits in the sand on river shores, discovered by the colonists as they searched for mineral resources along the coastal plain of Virginia and toward the Fall Line near Richmond and westward into the Piedmont (Sweet, personal communication, August 14, 2004). Mica, in the form of biotite, also may have been confused for gold. Despite the efforts of German mineral men and gold refiners from England, gold was not found for the Virginia Company or the crown, which lay claim to one-fifth of the gold and one-fifteenth of the value of copper discovered in Virginia (in the first charter dated 10 April 1606).

In the "instructions by way of advice" given by the Council for Virginia, Captain Newport and Captain Gosnold were charged with taking 40 men upriver and into the surrounding territory. Where high hills or lands were seen, Gosnold would then split with half the men and six pickaxes to look for minerals. Should any exploration parties take native guides, they were advised not to let them slip away, but take a compass and keep track of directional changes to avoid being abandoned and lost (Brown, 1993). It should be apparent that Captain Newport's two early transports of "gilded dirt" to England, like Frobisher's or Ralegh's, returned large testing samples for trials by different assayers.

Was anyone at Jamestown familiar with precious metals or mineral exploration? Newport, married to the daughter of a goldsmith, had previously invested in a ship with London goldsmiths. In 1596, he was part owner of the privateer Neptune with prominent goldsmiths Francis and Richard Glenville, who were well established in their trade and primarily interested in gold, silver, and precious stones. Captain John Martin, who supervised metallurgical work at Jamestown, was the son of England's Master of the Mint. Bartholomew Gosnold, captain of the Godspeed in 1606, had explored "the North part of Virginia" (the New England coast) in 1602, taking Captain Bartholomew Gilbert, a London goldsmith and no relation to Sir Humphrey Gilbert, with him on the Concord. Having returned to England on the Susan Constant with a sample of "gold" on 29 July 1607, Newport brought back to Jamestown two goldsmiths (William Johnson and Richard Belfield), a jeweler (Daniel Stallings), and two metallurgical refiners (William Dawson and Abram Ransack) with the First Supply ship in January 1608 (Barbour, 1967). Richard Dole joined James Read as the colony's second known blacksmith. If the Frobisher expeditions can be taken as models for mining logistics, then blacksmiths would have been important for the repair of pickaxes and other tools used in Virginia.

The subject of mines and miners appears again and again. A passage that appears in John Smith's "A True Relation" but none of his subsequent writings describes mineral exploration with Captain Christopher Newport following Newport's return and resupply in January 1608: "Captain Nuport in the pinnace leaving me in the barge to dig a rock where we supposed a mine at Cinquaoteck, ... which done, ere midnight I arrived at Weroacomoco, where our pinnace anchored, being 20 miles from Cinquaotecke" (Barbour, 1967, Vol. I, p. 77-78). Virginia Company

instructions of May 1609 directed that Virginia fleets return with valuable commodities from other countries, tribute, and exports such as iron and steel from the Virginia colony such as steel and iron.

In 1610, George Percy reported there was a conspiracy plotting among "some of our men which wrought in iron mines to run away with a bark [a ship]" (Haile, 1998, p. 511). The plot was unsuccessful. While it seems to confirm the presence of iron mines, this account does not mention what type of mining was taking place, and no sources have yet confirmed or denied that colonial miners worked in underground shafts in Virginia, although the process of mining was well-known in England.

William Strachey (1609) refers to "divers sorts of minerals, especially of iron ore lying upon the ground for ten miles circuit," which would make surface mining a distinct possibility (Stratchey as cited in Haile, 1998, p. 442). The eighteenth-century "Diderot Encyclopedie" (1762-1777) illustrates techniques of superficial and deep mining in Europe, as well as quarrying and transport of minerals "found in earth and in water" that may have been similar to those colonial authorities hoped to implement.

The colonists discovered bog iron (limonite or other iron-cement-sand deposits) as they searched for mineral resources along the coastal plain of Virginia and toward the Piedmont. In "James City County, Keystone of the Commonwealth" (1997), author Martha McCartney relates an account by agronomist Edmund Ruffin in the mid-nineteenth century concerning his visit to the Stonehouse, a stone structure then in ruins. Its walls (two feet wide in the basement, eighteen inches above) were constructed of ferruginous sandstone (limonite or bog iron with carbonate inclusions) found in abundance nearby. Because bog iron was readily accessible along rivers and in bogs, and exposed in eroding cliffs, the quarrying process could have taken place several ways in the colony: by boat, using long-handled scoops, or by mining with picks and shovels in swamps and low-lying areas. Bog iron was processed to make chisels that Smith describes, and may have been in two barrels of iron ore samples he sent back to the Treasurer and Council of Virginia as a result of his explorations.

An expedition led by Captain Christopher Newport after his return with the Second Supply in autumn 1608 went from the Falls (near modern-day Richmond) to the boundaries of the Powhatan/Monacan territory (near modern-day Columbia and Fork Union) where the James and Rivanna Rivers come together, then back to Jamestown. Smith, then President, was not a member of the expedition but described it in "The Generall Historie," "in our returns we searched many places we supposed mines, about which we spent some time in refining." Smith's "Virginia" map shows both areas he explored and those known to him only "by relation," identified by Maltese crosses (Barbour, 1967, Vol. II, pp. 184-185).

In 1609, an ocean away in Ireland, iron ore had been found in abundance and London agents were already assessing where and how the ore was deposited (in mines, bogs, basalt quarries and other sites) and took samples of ore, iron, and steel back to English authorities. By 1612, an estimated one hundred tons of Virginia iron had been shipped to England with Captain Christopher Newport and smelted into 16 to 17 tons of useable iron. In 1612, William Strachey made note of an iron mine that Sir Thomas Dale described in his letters to the lords of the Council. However, a mine could also represent shallow pits in the ground or swampy areas where bog iron was dug up. The initial gold rush at Jamestown seemed to subside as other challenges confronted the colonists. The second wave of exploration began after Thomas West, Baron de la

Warr, arrived to renew the colony in 1611. Lord de la Warr's push toward the fall line to search for gold, silver, and the South Sea is well documented. Through his perseverance, a fort was constructed near the Falls, marking English intentions to explore beyond the Blue Ridge.

In "The Historie of Travell in Virginia Britannia," William Strachey noted, "These waters wash from the rocks such glistering tinctures that the ground in some places seemeth as gilded where both the rocks and the earth are so splendant they contained more than probabilities. Sure it is that some minerals there have been found" (Wright and Freund, 1953, p. 34). The region Strachey described 40 to 50 miles beyond the Fall Line is in the heart of the gold-pyrite belt between modern-day Columbia and Fork Union, Virginia. Here, a sizeable number of gold deposits and occurrences were mined in the nineteenth and twentieth centuries. Previously, Christopher Newport had explored in the same area as far as Rassawek, an Indian village located near Fork Union.

In 1729, in what is now Woodbridge, Prince William County, "King" Carter built a landing to ship copper ore at Occoquan (Sweet, 1985). In 1733, the Slith Mine located in Mecklenburg County was worked for copper, gold, and silver by one miner and two helpers. In 1836, William Barton Rogers reported that virgin copper had been reported in many parts of the Blue Ridge in thin veins and small masses, and small samples picked up (Rogers, 1884, p. 134. Watson also reported in 1906 that "the ores of copper have wide distribution over the State, although there are at present but few producing mines," with deposits in the Piedmont, the Blue Ridge, Southwest Virginia, and in Loudoun and Culpepper counties.

In North Carolina, copper was mined as early as 1856 in Person County and in the 1800s and 1890s in Granville County. (Watson, 1907). Watson reported deposits from Front Royal south in Warren, Fauquier, Rappahannock, Madison, Page, and Greene counties. Amherst County was noted for old openings as "the endeavor of earlier explorers to find workable deposits" and in the Blue Ridge, "copper deposits have been known to exist...since the earliest settlements." Watson also wrote, "the native copper of the region probably furnished the Indians with the metal from which their ornaments and axes were made" (Watson, 1907, p. 503).

In his "Historie of Travell," William Strachey noted "We do alreaddy heare the Indians talk both of Allum-Mynes and copper to the South-ward, where hath bene sufficient tyme for digestion, all which we must submitt to more cliere Discoveries" (Wright and Freund, 1953, p. 40). Strachey also wrote of the "Bocootawwonaukes," or a people so called by Powhatan, living north of the Falls and northeast beyond the Monacans. According to Stratchey, Powhatan said that they "doe likewise melt Copper and other mettells; how true we must leave to further discovery." Strachey wrote that the "Boocootawwinnauke are said to part the sollide Metelle from the stone without fier, bellowes or additament, and beat yt into plates, the like whereof is hardly found in any other parte of the world" (Wright and Freund, 1953, p. 132) In defining the borders of Powhatan's domain, Strachey wrote "... and west-ward he Commaundes to Manahassanugh, which standes at the foot of the mountaynes, from Chesapeak [perhaps modern-day Charlottesville] or the mouth of our Bay 200 myles: Nor-west, to the borders of Masssawomeck, and Bocootawwonaugh: Nor-east and by east to Accohanock, Accomack, and some other petty Nations, lying on the East syde of our Bay" (Wright and Freund, 1953, p. 35-36). Beyond the Bocootawwonaukes at 44 degrees latitude, Strachey wrote, of the country called Pamaquid, in which "our westerne Colony (vpon the River

of Sachedehock) [Fort St. George, or the Popham Colony, on the Sagadahoc River in modern-day Maine] was sometyme planted" (Wright and Freund, 1965, p. 35). It is tempting to link the Boccotawwonaukes and Monacans to Virginia Indians mining and smelting copper, however, the Powhatans, like their English counterparts, were stymied in comprehending the true geographic distances involved in their descriptions to the English. Strachey's descriptions show that in the second decade of English occupation, the colonists continued to observe their environment and question the Virginia natives about it.

In "Marvelous Possession: The Wonder of the New World," Stephen Greenblatt emphasizes that the critical cultural difference between European and American peoples was the presence or absence of writing, and that this difference virtually determined the outcome of their encounter." Greenblatt goes further to discuss the technology of symbolism (Greenblatt, 1991). As part of the process of possessing Virginia, English colonial implementation of representational technology as manifested in their maps and writings was an inevitable factor in the conquest of Virginia. A map's accuracy and measurement of geographic space were dependent on agreed-upon units of measurement and territorial limitations. Members of different cultures with different conceptions of time and space could probably agree on the amount of ground or water that could be covered in a day by foot; however, hostile forces could prevent them from verifying accounts of the peoples and places beyond their safe zones. Smith, Strachey, and colonial authorities would have liked to range freely beyond the mountains of "Britannia," but depended on native information in that era. However, the Powhatans were limited by the perimeters of their territory or safe zone. Even under ideal communications conditions, Powhatan leaders may have restricted or redirected revealing disclosures for the protection of their people.

While the factors outlined above are essential to understanding the limitations of colonial mineral exploration, there may be a third: interactions between the English and the Powhatans, as noted in the previous chapter, that have been overlooked. A case in point is the Powhatan warrior Namontack, who was cited by Strachey as the discoverer of a mine within six miles of the head of the Falls. Significantly, the colonists named the mine for Namontack, an action out of keeping with the English desire to honor their own with place names. John Smith mentioned that Namontack was a guide on several occasions for him and for Christopher Newport. Irishman Francis Maguel's 1610 account may exaggerate in speaking of "many iron mines (to work which, as well as to work other metals they have already erected there some machinery [mills]," his description of sailing to England with the "son of the emperor" fits with Namontack's sailing to England with Christopher Newport on 10 April 1608 and arriving there on 21 May 1608 (Haile, 1998, p. 451). The Indian warrior returned to Virginia with Newport in September 1608 (Maguel as cited in Haile, 1998, p. 451).

When Newport met with Powhatan after his return to the colonies, he requested additional men and guides for an expedition to Monacan territory. Powhatan refused to supply anyone other than Namontack. Refiner William Callicut had arrived, possibly on Newport's Second Supply in September 1608 with Namontack. Callicut accompanied Newport, the colonial council members, five appointed leaders, and 120 chosen men in the search for mines. According to Smith, he conducted mineral trials on location, claiming to extract a small amount of silver ore. Strachey also described two other silver mines midway between two Monacan villages 14 miles apart: one with ore located only 2 to 3 feet into the ground and the other attested to by the Swiss

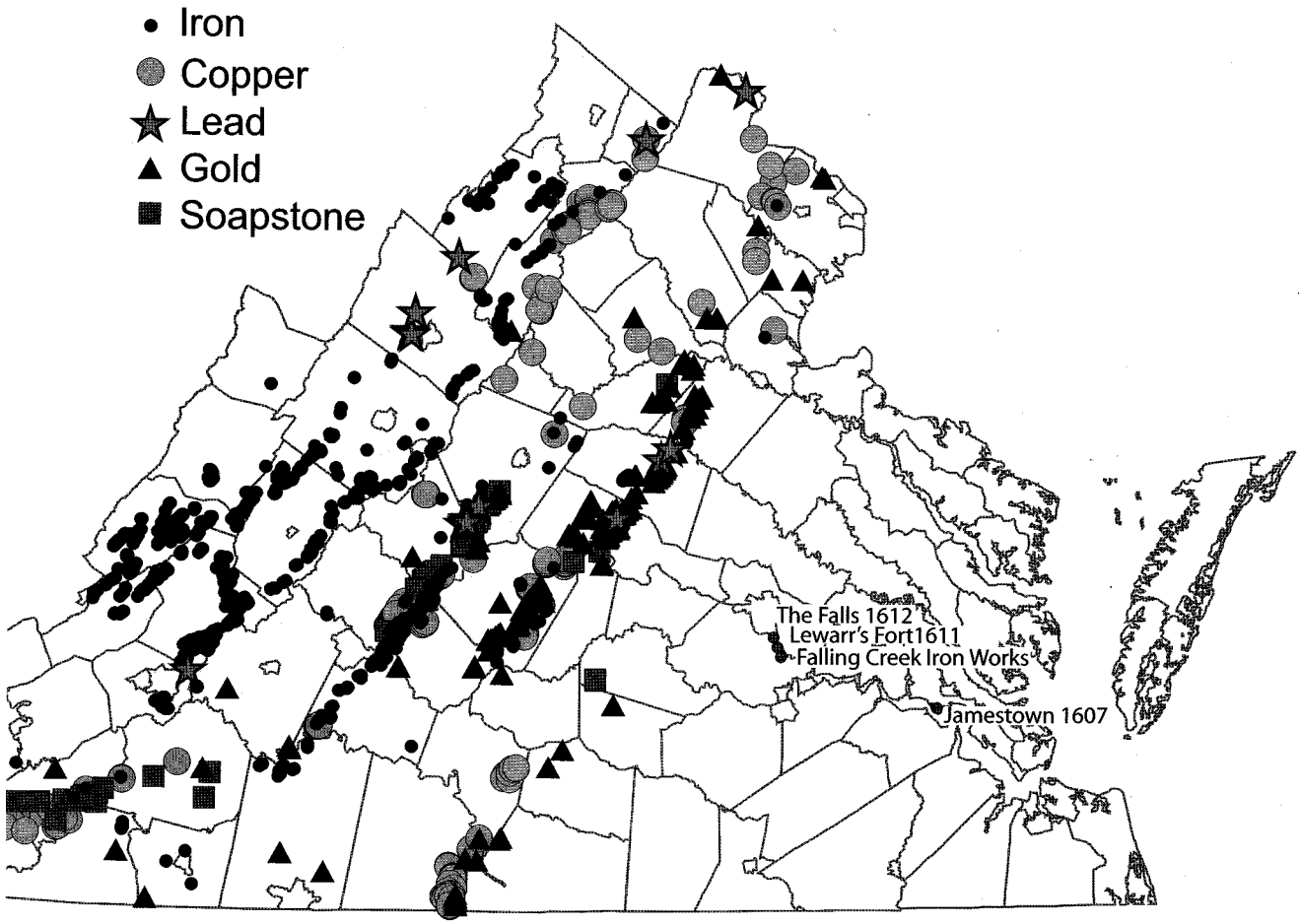

Figure 7. Locations of early colonial settlements and select, relatively recent, mineral-mining extraction sites. Mineral-resource locations from Virginia Division of Mineral Resources files and databases.

William Hendrick Faldoe.

When Faldoe returned to England with Captain Newport, the mineral man's assurances persuaded London Company authorities to put him under contract. However, in 1610 Faldoe died with the silver mine's location still secret. John Smith related the story of Valdo or Volda[y] or Faldoe, concluding his account that with Faldoe's return with Lord de la Warr, having been "found a meere Imposter he dyed most miserably." (Smith as cited in Barbour, 1967, Vol. II, p. 226). Strachey reported that Lord de la Warr had shown him a Portuguese map in which "our seat is laid out and in the same two silver mines pricked down" (Stratchey as cited in Wright and Freund, 1953, p. 31).

Was there actually any silver? There are several possibilities. Weathered muscovite looks similar. According to Virginia Division of Mineral Resources geologist John Marr, it is possible there may have been a very small amount of silver in the alluvium near Richmond. Records of mining operations in Virginia date from 1829 and show that silver was produced from both quartz and copper ores (Marr, personal correspondence, October 22, 1999). In 1904, eleven counties in Virginia contributed to the production of gold and silver (Figure 7). Silver was located in quartz veins associated with gold in both Montgomery and Floyd Counties on the west side of the Blue Ridge Mountains and at the southeast base of Pilot Mountain (Watson, 1907, pp. 564-565). As

of 1976, the Division of Mineral Resources had noted 40 mines in Virginia that reported the presence of silver in varying amounts (Sweet, 1967). Additional silver mines, prospects, and occurrences have been found since 1976 (Sweet and Trimble, 1982), Linden and others, 1985), and (Sweet and Lovett, 1985).

Comparison of historical events and geologic documentation reveals that limitations born of territorial hostilities, technology and unforeseen events were factors in their perceived failure to locate precious metals. One such factor was de la Warr's ill health and his withdrawal from Virginia in 1611, removing one of the major proponents of mineral exploration. Although the ailing Governor for life attempted to return to Virginia in June 1618, he died during the voyage. From that time on, the priority gradually moved to exploitation and manufacturing of iron, continuing activity near the Falls. Yet in Don Diego de Molina's letter to Don Alonso de Velasco dated 28 May 1613, Molina wrote:

> ...They have discovered some mines which are considered productive, altho' they have not yet been able to benefit much by them, until they shall be well established here. There are great expectations of what they will find in the mountains in great abundance; so say the Indians and offer to show the places which they know. They say at the headwaters of the rivers, after they have some forth from the mountains, there is a great quantity of grains of silver and gold; but as they do not attach any value to them, but only to copper which they esteem very highly, they do not collect them. Until now these men have not been able to go out to discover them, however eagerly they may desire it...(Brown, 1993, vol. II, p. 646).

Of over 700,000 prehistoric and historic period artifacts uncovered as of March 2005 at the original location of James Fort by the Association for the Preservation of Virginia Antiquities (APVA) Jamestown Rediscovery staff, over 60,000 are geologic materials. The number of artifacts continues to rise as the excavations continue. According to project curator, Beverly Straube, apart from native stone tools and flakes, there are other lithics found in the colonial contexts that represent local cherts and sandstones, English flint and chalk, Bermuda coral and limestone, and samples of volcanic rock (Straube, personal communication, March 1, 2005). One explanation for the presence of these specimens is that the mineral men or prospectors were collecting examples wherever they landed or explored. A collection of semi-precious stones was found in the fort's pre-1610 fill of Structure 165. In 1611, Thomas Dale wrote: "And at the Falls, I cannot onely testifie of corne, but of all probabilities of mines, when – our tyme shall serve (which may not be yet) and where I gathered many scattered pieces of Crystall" (Brown, 1993, p. 505).

The ongoing archaeological discoveries centered in the fort site on Jamestown Island indicate the presence of industrial activity almost 400 years ago. As at Roanoke, the crucibles and distilling equipment in the National Park Service's Colonial National Park collection are indicative of metallurgical testing. Related finds include: evidence of iron smelting (Structure 111); brass measuring scales (Refuse Pit 1); bog iron samples and quartz crystal (Kiln area); beaker fragments and a small vial (Refuse Pit 1); and coral and fossil pieces along with a small crucible (Structure 128). A seventeenth-century alembic was found at Martin's Hundred during excavations from 1976 to 1980 (Hume, 1982). William Kelso and his staff of archaeologists have excavated other pieces of distilling equipment of the type used by refiners in the fort context at APVA Jamestown Rediscovery. These artifacts, among them crucibles, distilling vessels, alembics, and cucurbits, have been described at length in published APVA Jamestown Rediscovery reports over the last

eleven years (Kelso and Straube, 2004). As this project uncovers more and more evidence of concerted efforts in industrial activity and trade, old concepts of colonial ineptness and lack of planning are losing credibility. An interesting parallel is the discovery of drug jars and butter pots at a number of seventeenth-century sites including The Maine, Jamestown, and Jordan's Journey. A period brass image of a Forest of Dean miner in the Newland Parish Church in the Grayndour Chantry Chapel shows him wearing a leather bag on his belt to hold such medicinal ointments or tools.

At Jordan's Journey, the outlying settlement in modern-day Henrico County, archaeological evidence included bog iron chunks, crucible fragments, and rocks listed as "non-local" by the archaeologists (Mouer and others, 1992). A 2004 examination of the artifacts stored in the collections at the Virginia Department of Historic Resources in Richmond, Virginia, by geologist Palmer Sweet did not include the so-called exotic or non-local rocks, as they were not available. In the 1992 preliminary report on archaeology prepared by L. Daniel Mouer and his colleagues, they noted that among the "more humble, but highly intriguing" artifacts were several pounds of rocks (micaceous schists and gneisses from the Western Piedmont) filled with glittery materials like biotite and pyrite. They concluded that these artifacts represented ore samples abandoned in site trash pits. Further, the team wrote:

> And yet they reveal either the presence of an extensive Indian trade in potential ore sources, or else the presence of English prospectors in the Piedmont fully 30 years or more before any are historically known to have traveled there (excepting, of course, Newport's 1608 expedition to the Monacans). At the very least, we need careful and expert geological identification of these materials so that we can determine the extent of this trading network, or exploration (Mouer and others, 1992, p. 163).

It is possible that related activities, including refining and mineral exploration, were taking place in the satellite settlement areas as authorities continued to press the search for mineral resources in Virginia. That hope, a driving force in colonization, was destined not to disappear but to be realized over the next four centuries. In a letter dated 16 April 1630, Sir John Harvey wrote to Secretary Dorchester, "I intend about September, when the heate is over, to travaille about 8 or 9 dayes journey above the falls to inform myself truly whether there be anie such silver mine as is or hath been commonly reported or not." Winter cut short Harvey's planned expedition with 170 men (Bruce, 1935, vol. I, p. 82). A later attempt with fifty men to look for gold and silver was made by Colonel Edward Hill without official approval twenty years later, proving that expectations still ran deep.

THE SIGNIFICANCE OF FALLING CREEK

The evolution of mineral exploration and mining technology in colonial Virginia should be compared to overall patterns of cultural transmission and adaptation. Martin Quitt's 1988 study of cultural evolution over space and time showed how immigrant leaders in Virginia fused their English background and response to new surroundings to create a legacy to succeeding generations of their families (Quitt, 1988). Joanne Bowen, Cary Carson, Willie Graham, Martha McCartney, and Lorena Walsh addressed the mutability of culture at "The Atlantic World and Virginia, 1550-1624" conference in March 2004. They proposed that seventeenth-century Jamestown and Virginia reflected an adaptive process going on throughout the Western Hemisphere: "Atlantic world scholarship has broken through to the important realization that cultures are made and

continually remade on location, not born at home and cloned abroad" (Bowen and others, 2004). The colonists learned by trial and error how to exploit the ecological environment of Virginia. As noted previously, the Irish spy Francis Miguel made unsubstantiated claims about Virginia. He testified to the Spanish that in the first three years of Jamestown, English settlers had erected machinery to work the iron mines. Miguel claimed to have carried, from a Virginia mine to England, an 80-pound sample that contained "the weight of three reales [the Spanish sixpence] of gold, of five in silver, and of four pounds of copper." (Miguel as cited in Haile, 1998, p. 449).

The second major wave of English colonial mineral exploration occurred after the Starving Time of 1610, when Lord de la Warr arrived as governor to restore and renew the debilitated colony. In a letter from Virginia Council members to the Corporation of Plymouth in February 1608, Thomas Smith, Edwin Sadness and others requested a ship and supplies to support a large supply of 800 men under Lord de la Warr. The Council members had already entreated William Herbert, Earl of Pembroke, to impress one hundred mineral and laboring men from the Cornish tin mines for the voyage in his capacity as lord warden of the stannaries " (Quinn and Quinn, 1983). According to the Oxford English Dictionary, stannaries were the districts comprising the tin mines and smelting works of Cornwall and Devon formerly under the jurisdictions of the Stannary courts; also the customs and privileges attached to the mines. The Governor would indeed send an expedition to search for mines above the Falls, "but the Indians were very troublesome and no mines were found" (Tyler, 1998, p. 39). Lord de la Warr also "nominated Captaine John Martine, Master of the Battery workes for Steele and Iron" (Brown, 1993, Vol. 1, p. 469).

In his "A trewe relyacon," Percy described aspects of the governor's dual search to find minerals and to further prove the existence of iron mines in the colony. Among the setbacks was an attempt by some of the men, including blacksmith James Read, who "wrought in iron mines to run away with a bark." When de la Warr sent another expedition toward the Falls, they were lured on shore by natives who then attacked them, leaving only one surviving expedition member. In another attempt, the governor sent a group of men ahead to the Falls to build a fort, winter over and continue mineral exploration the following spring, but sickness, scarcity, and severe Indian attacks were discouraging. The final blow was de la Warr's return to England in March 1611 due to ill health with Dr. Lawrence Bohun. Sir Thomas Dale took up the cause and "hath mentioned in his letters to the lords of the council of a goodly iron mine" (Bruce, 1935, Vol. I, pp. 445-446).

William Strachey reported that in 1610, Captain Samuel Argall found "a Myne of Antimony, which (as aforesaid) never dwells single, but holdes assured legue with Quicksiluer, as likewise a myne of Lead" among the Patawomecks (Wright and Freund, 1953, p. 132). When tobacco began to emerge as Virginia's "green" gold after 1613, the structured search for precious metals declined. Both human and economic resources were increasingly redirected. The period from 1606 to 1622 shows a learning curve related to mines, minerals, and metallurgy. Colonial authorities gradually shifted from finding a quick profit in gold and silver to launching native iron manufacturing as an important colonial industry. Diego de Molina was reputed to have shown the King of Spain a piece of silver he obtained through some means while in Virginia and repeated news of a silver mine discovered there and reported in London in June 1618 (Hume, 1994).

Between 1618 and 1619, records of the Virginia Company reflected this goal. Falling

Creek provided a waterpower supply and available timber suitable for an iron works and blast furnace, and ships could be used to transport both ore and processed iron along the James River. Between 1619 and 1621, Virginia Company officials made ambitious plans. By 1619, 150 workers had been sent under a Captain Blewett to set up three iron works, coming from Warwickshire and Staffordshire (about 110 workers) and Sussex (about 40 workers), "all framed to *Iron-workes*" (Force, 1999, vol. III, p. 13). Despite the death of Blewett and other specialists from disease and the death at sea of more chief ironworkers en route, another 20 workers were planned for the operation in 1621 under Blewett's replacement, John Berkley. Those workers included founders to cast the metal, filers to smooth it, refiners, blacksmiths, and auxiliary workers like carpenters, traders, and servants (Egloff, 1989). Expectations rose for a nearby shipbuilding operation, with the blast furnace was scheduled to begin operations on Good Friday, 22 March 1622. On that day, only two children escaped out of twenty-nine residents (including twenty-five men, two women), and the iron production facility was reportedly destroyed as part of the uprising against the English (Higgins and others, 1995, p. 6). In E. N. Hargus's "Ironworks on the Saugus" (Hargus, 2001), the author suggested that if the blast furnace were in operation, its total demolition would be a considerable native achievement. According to the 1994 archaeological findings, some auxiliary buildings might not have been completed or even under construction at the time of the attack.

Throughout the colonial period, the Powhatans exchanged food and information for copper and metal tools and absorbed metal and steel into their culture. Fear that English trade in iron would strengthen Monacan power may have accelerated the calculated Powhatan attack on the blast furnace and the colony as a whole. The year after the 1622 uprising, the Virginia Company made more modest plans for a bloomery. In 1623, Jamestown had at least one blacksmith, James Blisse, and the King's Privy Council had created a commission to investigate the Virginia Company and colonial conditions. The short-term destiny of mineral exploration, mining and metalworking – as well as the Jamestown freight wharf or pier - seems to be reflected in this description in "Statements of Seamen as to Conditions in Virginia" between April and June of 1623, which demonstrates significant changes had occurred at Jamestown.

> Armours, swords, musquets, truncks and such like goods, lye a fortnight together uncared for, everie tide beeing overflowed with water and the trunks readie to be swallowed. Lilkewise Iron bars and sowes of Ledd, and milstones and Grinstones and Iron furnaces, lye right against the same places sunk and covered with sans, the water dayly overflowing them (Kingsbury, 1935, vol. IV, p. 93)

In the 15 years between the English arrival in Powhatan territory and the destruction of the long-awaited, but uncompleted, blast furnace, there was an ebb and flow to expectations of mineral wealth from precious metals and stones, as has been shown. Concurrently, an iron-making industry in Virginia was moving forward, haltingly at times, with exaggerated claims often overshadowing less dramatic realities. Yet in 1650, a colonist still wrote: "Here are abundance of Iron Mines/here bee silver and gold mines but they cannot bee found out/other mines I know not" (Upchurch, Ferrar Papers, document #1182). A succession of iron furnaces followed in the early 18th century and by 1836, the Tredegar Ironworks was established in Richmond, operating during the War Between the States and producing fifty per cent of the Confederate cannons. Despite a decline after the war, it remained in service until destroyed by fire in 1892. Falling Creek was

the forerunner of these ironworks, and deserves further study for its impact both positive and negative on the colonial ironworking industry in Virginia.

CONCLUSIONS

Ralph Hamor entreated his countrymen in his "A True Discourse of the Present State of Virginia" to hearken unto Caleb and Joshua of the Bible, saying, "Let us go up at once and possess it, for undoubtedly we shall overcome it." (Hamor as cited in Haile, 1998, p. 840). In "A New Face on the Countryside: Indians, colonists, and slaves in South Atlantic forests, 1500-1800," Timothy Silver (1990) concluded that Indian subsistence patterns, as opposed to their own "God-given" and proper use of the land, convinced colonists that they were justified in organizing and transforming the colonial landscape. In contrast to the Spanish empire in America, the English colonists were prepared to mine for gold and precious stones themselves instead of using native labor as Martin Frobisher's second and third expeditions proved before Jamestown's founding (Andrews and others, 1978). Although there is some evidence that Powhatan Indian knowledge and skills extended the boundaries and viability of colonial mineral exploration, documentation of such interactions is limited to a few written statements by the English. Differences in languages and communication as well as cultural perceptions of time and space led to misunderstandings of and by each culture. James Merrell has pointed out that during the English conquest of Indian territory in early America, the vast majority of natives "remained illiterate, inhabitants of a symbolic universe they were unable to decipher," communicating mainly for trade purposes (Merrell, 1991, p. 131).

The Powhatan Indians' knowledge of natural resources was valued and recorded by the English in the early colonization period because it enabled them to use the environment for their own benefit and adapt to it at a faster rate. However, David Beers Quinn concluded that from the European perspective, the earliest accounts of the New World were "if often naïve, the least biased" (Quinn, 1990, p. 17). As he wrote in "Explorers and Colonies: America, 1500-1625," "Clearly, almost every source ought to be looked at again and with a many-faceted approach. Already we appreciate better than we did the significance of data on natural history contained in the early exploration documents" (Quinn, 1990, p. 14). In the 1620 Virginia Company records, a valuation of the commodities "growing and to be had" included the following Virginia mineral resources: Iron, ten pounds the ton; Red earth Allenagra, three shillings the hundred; Red Allum, called Carthegena Allum, ten shillings the hundred, and Roach Allum, called Romish Allum, ten shillings the hundred. Alum springs were later identified in Rockbridge, Bath, and Rockingham counties (Rogers, 1884). Instructions for shipping specified "Cristall rocke: send as much as you can, and any sort of Minerall stones, or earth that weighs very heavy" (Kingsbury, 1935, vol. 3, p. 238). What this list tells us 400 years later is that despite the Virginia Company's inability to successfully mine gold, silver, and precious stones, iron and medicinal clays continued to be valued as commodities. Prospecting did not disappear, nor did the hope that unusual specimens might prove profitable.

Despite the destruction of the Falling Creek blast furnace, there would be more exploration along with the evolution of the Virginia iron and coal industry in the centuries to follow. If English explorers of the late sixteenth and early seventeenth centuries could compare their maps to those of modern Virginia and North Carolina, it would show that mineral resources were ac-

tually near areas of exploration. However, it is clear that the technical developments of the time and cartographic knowledge simply could not keep up with early colonial hopes and expectations in a wilderness environment. As archaeological work is unveiled from James Fort, Werowocomo, Kiskiack, and other colonial settlement sites, it may show a greater degree of contact and conflict between the Virginia English and the Powhatan Indians, conflict involving their own perceptions and use of natural resources as well as conflict with each other. Both cultures continually re-shaped the land to suit their traditional and changing needs.

When twenty-first-century archaeologists, ethnohistorians and anthropologists incorporate chemical analyses of copper artifacts into their studies, science is demonstrating its value to all three disciplines regarding early colonial material culture, especially analysis of copper from the Appalachian belt. Native copper and European copper have different "fingerprints" or chemical profiles: native copper has lower levels of arsenic, lead, and antimony than its European counterpart, as shown in proton-induced X-ray emission spectrometry and neutron activation techniques (Rountree and Turner, 2002). Geoarchaeological research in determining sourcing of copper artifacts shows promise as a tool in expanding historical narratives (Rapp and others, 2000). Trace-element sourcing is becoming a significant archaeological tool in tracing trade and distribution patterns in the Contact period. Analysis of two early Jamestown-era copper artifacts excavated after 1998 at the historically important Powhatan Indian village, Kiskiack, revealed that one copper piece was English (possibly official trade, because it matches copper artifacts excavated at Jamestown) and the other piece Swedish (possibly a remnant of trade by sailors) (Petkofsky, June 29, 2004). Similar analyses at James Fort by the Association for the Preservation of Virginia Antiquities (APVA) Jamestown Rediscovery and at the Powhatan village, Paspahegh, have shown that copper goods from imported sheet copper were produced and/or traded by early colonists. That trade was highly valued in early interactions between the two cultures, at least until the supply began to exceed native demand for copper. Analysis of copper artifacts from Werowocomoco, a Powhatan political center circa 1607 archaeological site, is currently being conducted to further investigate early Anglo-Powhatan trade. In addition to providing evidence of trade, chemical analysis and research by Carter C. Hudgins indicates that copper-related metallurgical trials were also being conducted in the James Fort period (Hudgins, personal communications November 18, 2004).

Scholars and scientists should acknowledge each other's abilities to read the past, whether in words or geologic formations. The land has a story to tell. As the English colonial era unfolded, those who had come before and mastered the landscape encountered newcomers with a vastly different technology and mindset. Their common denominator was survival using available resources: what the land could provide for immediate and long-term use. Due to the difference in their belief systems and technology, sharing the land was impossible and the changes born of economic encroachment were immediate. The English intended to make the environment their own in their own words, as our national historical narrative has demonstrated. With the limited documented history the Powhatans and other native tribes have left behind, the richness of their culture and technology can only be hinted at presently, and geology helps to illuminate the story.

What if the threat of native attack had not impaired more exploration and mining parties in the auriferous or gold-bearing region between Jamestown and modern-day Richmond? What if mineral men on the scene like William Hendrick

Faldoe and Newport's exploring party had lived longer to find, prove, or disprove their claims, rather than die from disease or Indian attack?

As archaeological excavations continue at James Fort and other colonial sites, significant evidence of mineral-related trade and industrial activities in the Virginia colony may emerge. In January 2007, Chesterfield County officials announced an amateur archaeologist's discovery on the banks of Falling Creek: visible ruins of the 1619 blast furnace. According to a Richmond Times Dispatch report, historians believe that several timbers exposed by heavy rains in 2006 are part of the furnace's foundation, and further study is planned. Today, a respect for the expertise and adaptability of Virginia's colonists and indigenous people is expanding. They rapidly developed knowledge about the New World landscape and each other This adaptive process, despite its trials, errors, and conflicts, was essential to the development of the colony and the future Commonwealth of Virginia. The reality underlying England's colonial quest for mineral resources -- with its conflicting dreams and perspectives, its yet unspoken "might have beens" -- has a rightful place in America's historical narrative.

ACKNOWLEDGEMENTS

The author sincerely thanks everyone who originally contributed to her Master of Arts thesis (The College of William and Mary, 2005). She is especially grateful to her husband, Jan, to C. Rick Berquist for encouraging her research from its genesis eight years ago, to editor Michael Upchurch for refining her words, and to the Division of Mineral Resources for making this publication possible.

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